PIONEER MATHEMATICIANS
OF
CALCUTTA UNIVERSITY

by
Dr. (Ms.) Purabi Mukherji
and
Dr. Mala Bhattacharjee

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FOREWORD

Established in 1857, Calcutta University has the unique distinction of being the first University in India, where Post-Graduate teaching and research in Mathematics was initiated. The Indian mathematicians, who did pioneering research work in the nineteenth and early part of the twentieth century and enriched the University of Calcutta deserve to be brought to the fore. This book is an attempt in that direction.

We have in our book discussed the contributions of the following fifteen mathematicians, who were connected with the University of Calcutta either as an important functionary or as a faculty member or as a student.

1.Sir Asutosh Mookerjee (1864-1924), 2. Prof. Ganesh Prasad (1876-1935), 3. Dr. Shyamadas Mukhopadhyay (1866-1937), 4. Dr. Bibhuti Bhusan Datta (1888-1958), 5. Prof. Haridas Bagchi (1888-1968), 6. Prof. Megh Nad Saha (1893-1956), 7. Prof. Satyendra Nath Bose (1894-1974), 8. Prof. Nikhil Ranjan Sen (1894-1963), 9. Prof. Rabindra Nath Sen (1896-1974), 10. Prof. Bibhuti Bhusan Sen (1898-1976), 11. Prof. Raj Chandra Bose (1901-1987), 12. Prof. Subodh Kumar Chakrabarty (1909-1987), 13. Prof. Manindra Chandra Chaki (1913-2007),14. Prof. Anadi Shankar Gupta (1932-2012) and the great lady mathematician Prof.(Mrs.) Jyoti Das.

There are fifteen chapters dedicated to the fifteen mathematicians mentioned above. Sir Asutosh Mookerjee has been discussed'over three sub-sections which ultimately combine to one whole chapter. We make a brief review of the contents of the chapters mentioned above.

Sir Asutosh Mookerjee was a versatile man, who almost single-handedly started the school of mathematical research in the country. He did some original research, mainly in the areas of Geometry, Differential Equations and Hydrokinetics. The total number of his personal research papers are seventeen and they were published in different national and international journals of repute. One of his important research paper is entitled "On the Differential Equation of a Trajectory" [JASB., 56, 1887, 117-120]. In this paper, Sir Mookerjee considered the solution of the differential equation of oblique trajectory of confocal ellipses as given by the Italian mathematician Mainardi. This solution being extremely complicated and cumbersome, it was impossible to trace the curve from it. Asutosh showed by an ingenious process that Mainardi's inelegant solution could be replaced by a pair of remarkably simply equations. From this, interesting geometrical interpretations could also be made. These elegent equations as established by Sir Asutosh have been incorporated by Prof. A.R. Forsyth (1858-1942) in his classical book on Differential Equations in latter editions. In another of his paper entitled "Remarks on Monge's Differential Equations to all conics" [PASB., Feb, 1888], Asutosh successfully gave geometrical interpretation on Monge's Differential Equations to all conics. His interpretation was that "the radius of curvature of the aberrancy curve vanishes at every point of every conic". Edwards in his book "Differential Calculus" has quoted this interpretation. Asutosh Mookerjee's research papers aroused a lot of interest amongst the British school of mathematicians of those times.

Sir Mookerjee was a trendsetter in the fields of research in Geometry as well as Fluid Mechanics. We have compiled his complete bibliography of mathematical research papers.

Prof. Ganesh Prasad, who is referred to as the "father of mathematical research" served Calcutta University in two phases and was involved both with the Departments of Pure as well as Applied Mathematics as the Head. In the Final Report, we have tried to show how he inspired young researchers and also highlighted his personal contributions. Prof. Prasad has published about fifty research papers in national and international journals and written a number of books. We have selectively discussed a few of his more important Publications. His paper entitled "Constitution of Matter and Analytical Theories of Heat" [Abhandulgen d.k., GWZG, 1903] is considered as an authoritative solution of a difficult problem in mathematical physics. Great German mathematician Felix Klein considered it as a very satisfactory solution. Another of his paper entitled "Expansion of arbitrary functions in a series of Spherical Harmonics" [MA, 1912] is considered to be a very important result and has been quoted in Hobson's book named "Theory of Spherical and Ellipsoidal Harmonics". Prof. Prasad did a lot of original work on the summability of the Fourier Series. Another research paper by Prof. Prasad entitled "On the differentiability of the integral function" [CJ Vol. 160, 1929] roused a lot of interest at that time. According to the mathematicians of the time it was an epoch making publication. Amongst the books written by Prof. Prasad, the following are still considered as classic contributions.

- A treatise on Spherical Harmonics and the Functions of Bessel and Lame (1930-1932)
- Six Lectures on recent researches in the theories of Fourier Series [Calcutta University Publications, 1928]
- Some Great Mathematicians of the Nineteenth Century (2 volumes)
- In this book, we have made a list of his important research papers and books.

Dr. Shyamadas Mukhopadhyay was the first Indian to obtain a doctorate degree in Mathematics in India. Inspired from his student days by his teacher Prof. W. Booth of Presidency College and later by Sir Asutosh Mookerjee, after joining the Calcutta University as a faculty in the Pure Mathematics Department, he seriously took up research in various branches of Geometry and made very valuable contributions. As remarked by another great geometrician of Calcutta University, Professor M.C. Chaki, "Dr. S. Mukhopadhyay's contributions in Geometry stand out prominently on account of their novelty and originality". Dr. Mukhopadhyay, while dealing synthetically with properties of a plane curve, specially in infinitesimal regions, developed new methods. These methods led to a number of interesting theorems on the existence of cyclic and sextactic points on a convex oval. The theorem which states that the minimum number of cyclic points on a convex oval is four, is now well known and is referred to in Geometry as Mukhopadhyay's "Four Vertex Theorem", the world over. The proof of the celebrated theorem was published in the Bulletin of the Calcutta Mathematical Society in 1909 ["New Methods in the Geometry of a Plane Arc, I, Cyclic and Sextactic Points", BCMS., Vol.1, 31-37, 1909]. In the paper entitled "Geometrical Investigations on the Correspondence between a right-angled triangle, a three right angled quadrilateral and a rectangular pentagon in Hyperbolic

Geometry" [BCMS., Vol.13, No.4. 211-216, 1922-1923], Dr. Mukhopadhyay established an important result and he concluded "We have thus the closed series of 5 associated right-angled triangles and the Engel-Napier Rules are shown to posses a real geometrical basis in the rectangular pentagon." In 1926, with the publication of the paper entitled "On General Theorems of Co-Intimacy of Symmetries of a Hyperbolic Triad" [BCMS.,18, No.1, 39-55, 1926] started a very fruitful collaboration between Dr. S. Mukhopadhyay and his legendary student R.C. Bose. We have compiled a complete list of Dr. Mukhopadhyay's 30 research publications.

In the backdrop of the early twentieth century mathematical world of India, Dr. Bibhuti Bhusan Datta's research contributions in Fluid Mechanics is rich, but his contributions in the field of History of Mathematics is stupendous. Inspired by his teacher and colleague, Prof. Ganesh Prasad, Dr. Datta pursued serious research in History of Indian Mathematics and wrote nearly 60 articles on the contributions of ancient Hindu and Jaina Mathematicians. In 1931, Dr. B.B. Datta delivered six lectures about ancient Hindu Geometry. In 1932, Calcutta University published these lectures in the form of a book entitled "The Science of Sulba—A Study of Hindu Geometry". These lectures were the fruit of intensive research by Dr. B.B. Datta. He revealed that the Vedic priests were concerned with practical problems involved in the construction of alters for carrying out religious rituals. In this way they developed a type of "esoteric geometry as their secret property". Dr. Datta's classical book "The History of Hindu Mathematics" Part I and II was published in 1935. Dr. A.N. Singh of Allahabad University was the co-author. In our book, we have analyzed Dr. Datta's contributions and have also made a complete bibliography of his research publications in Fluid Mechanics as well as in the History of Mathematics.

Prof. M.N. Saha, an illustrious student of the Department of Applied Mathematics, Calcutta University was elected an F.R.S. in London for his outstanding research in the fields of Astrophysics and Electromagnetic theory. He is world famous for his "Thermal ionization Theory". This discovery known the world over, as "Saha's Thermal ionization Theory" transformed spectroscopy into a precise, quantitative method of investigating the physical and chemical conditions inside the Sun and the stars. Saha's work was instrumental in inspiring hectic scientific activity across the world. Following Saha's inventions, scientists of Cambridge in U.K. and Harvard in U.S.A. made important contributions.

Prof. S.N. Bose, the first M.Sc. from Calcutta University and a star product of the Department of Applied Mathematics was also elected an F.R.S. from London. S .N. Bose worked on a number of topics in various branches of science. But his most outstanding work was "Planck's Law and the Light-Quantum Hypothesis" which was published in Z. Physik in 1924 with a note from Albert Einstein. As acknowledged by both Dirac and Einstein, the new statistics derived by Bose in this research paper laid the foundation of Quantum Statistics. With the discovery of this statistics known as "Bose-Einstein Statistics", Bose is considered a giant among mathematical physicists of the world. Einstein adopted this idea and extended it to atoms. This led to the prediction of the existence of the phenomena which became known as "Bose-Einstein Condensate". This condensate is a dense collection of Bosons (which are particles with integer spin, named after Bose by Dirac). With recent observations of Bose-Einstein Condensation in the dilute atomic gases at temperatures in milli-kelvin and micro-kelvin ranges, S.N. Bose's contributions has brough his name to the frontiers of contemporary Theoretical Physics. Particle Statistics as derived by S.N. Bose is considered by the scientific community as one of the top ten achievements of the 20th Century Indian Science.

Prof. Nikhil Ranjan Sen did research over a wide range of subjects and topics. He did pioneering work in the fields of turbulence and cosmology. In 1924, Prof. Sen took over as the "Rashbehary Ghosh Professor" of Applied Mathematics. Apart from his own brilliant research contributions, he introduced new subjects in the Post-Graduate curriculum and inspired his young colleagues and research associates to take up original and challenging problems and solve them in modern areas like Relativity, Astrophysics, Quantum Mechanics, Geophysics, Statistical Mechanics, Fluid Dynamics, Magneto-Hydrodynamics, Elasticity and Ballistics. He was the fountain-head of inspiration to research workers in Calcutta University and under his dynamic leadership the Department of Applied Mathematics became a vibrant centre of teaching and research and earned a reputation throughout the country, which would be hard to match. He was very rightly called the "Father of Applied Mathematics" in India. We have compiled the complete list of his personal research contributions.

Prof. Rabindranath Sen was a student and later a faculty member of the Department of Pure Mathematics. From 1954, for seven years he served the Department as the "Hardinge Professor" of Pure Mathematics. In his personal research, he has made enormous contributions in the fields of Differential Geometry of Riemannian and Finsler spaces. M.C. Chaki, the most famous student of Prof. R.N. Sen has stated "Sen's investigation on the behaviour of an arbitrary parallel displacement in a metric space resulted in the discovery in 1949-50, of an algebraic system of affine connections in which Levi-Civita parallelism could be identified." This work is considered as highly significant and has been referred to by I.M.H. Etherington of Edinburgh University as "Senian Geometry". We have compiled his complete bibliography.

Professor Raj Chandra Bose was a student of the Pure Mathematics Department and became a legendary research worker under the guidance and inspiration of Dr. Shyamadas Mukhopadhyay. He is famous for his contributions in Geometry and Mathematical Statistics. The father of Statistics in India, Prof. P.C.Mahalanobis persuaded R.C. Bose to join the newly set up Statistical Institute in the late thirties of the twentieth century. R.C. Bose was a pioneer in using finite geometries, finite fields and the combinatorial methods in the construction of designs. In 1938, his paper entitled "On the application of properties of Galois fields to the construction of hyper Graeco-Latin Squares" [S, Vol.3, 1938, 323-339] is very significant. In the introduction of that paper, Raj Chandrs Bose had written "It is hoped that the properties of Galois fields and the finite geometries connected with them, will prove useful in many problems of experimental design and the author hopes to pursue this matter in subsequent papers". Indeed until the middle of 1950, Professor Bose was mainly preoccupied with the development of a mathematical theory of design. But perhaps his most important work in the field of Mathematical Statistics was written in collaboration with another famous mathematician Prof. S.N. Roy and the paper is titled "The Distribution of the Studentised D^2-staistic" [S,4, 1938, 19-38]. It was critically acclaimed by

R.A. Fisher. According to him, the above mentioned paper has carried the work a distinct step forward. Prof. P.C. Mahalanobis too wrote that the paper supplied the necessary mathematical tool to use the D^2-statistic when only the sample values of dispersion were known. We have very carefully compiled Prof. R.C. Bose's complete bibliography.

Professor Bibhuti Bhusan Sen, a notable student of the Department of Applied Mathematics had the good fortune of being taught by such stalwarts as Prof. S. N. Bose and Prof. N.R. Sen Inspired particularly by Prof. S. N. Bose, he was the man who practically initiated modern type of research in the field of Solid Mechanics. His research papers entitled "Two dimensional boundary value problems of elasticity" [PRSL, A 187(1946), 87-101] and "Note on the direct determination of steady state thermal stresses in circular discs and spheres" [BCMS, 56 (1964) 77-81] deserve special mention. Apart from his own rich contributions in various branches of Solid Mechanics, he built a very strong school of research workers as well. He has the unique distinction of guiding more than fifty students for their Ph.D. degrees. His complete list of research publications has been compiled by us.

Prof. Subodh Kumar Chakrabarty was a student and later a faculty in the Department of Applied Mathematics of the University of Calcutta. In 1963 he was made the Rashbehary Ghosh Professor of Applied Mathematics and served there till his retirement in 1974. In his personal research, he collaborated with H.J. Bhabha and made remarkable contributions in the field of Cosmology. Prof. Chakrabarty is well known in the scientific community for his researches on "Cascade Theory" and "Theoretical Seismology". During his tenure as the Head of the Department, he inspired many young students to take up research, in the field of Theoretical Seismology and Geophysics. His full list of research publications have been compiled by us.

Professor Manindra Chandra Chaki, a student and later a faculty of the Department of Pure Mathematics has made notable contributions in the fields of Riemannian Geometry, Classical and Modern Differential Geometry, Theoretical Physics, General Relativity, Cosmology and History of Mathematics. Perhaps a very noteworthy contribution of Prof. Chaki was in 1987, when he introduced the notion of Pseudo-symmetric Manifolds, which is known in mathematical literature as Chaki Manifold. He guided more than twenty research students for their Ph.D. degrees in various branches of Mathematics.

Professor Anadi Shankar Gupta, a student of the Department of Applied Mathematics and a much admired faculty of I.I.T., Kharagpur is very renowned for his contributions in the field of Magneto-hydrodynamics and the stability of flows of Newtonian and Non-Newtonian fluids. He was responsible for building up a strong school of research in Fluid Mechanics. We have compiled Prof. A.S. Gupta's complete bibliography.

Professor (Mrs.) Jyoti Das has made important contributions in the fields of Special Functions, Eigen Function Expansions and Ordinary Differential Equations.

Contributions made by the different mathematicians mentioned above is really remarkble. Apart from their personal brilliance and commitment, a thing, which should deftnitely come into consideration, is the fact that many of them, particularly, in the early part of the twentieth century worked under very difficult conditions: They did not have access to any modern gadgets, not even to calculators. But inspite of such impediments, their research works made a mark in the world of science and it was critically acclaimed by the mathematical community both in India as well as abroad. We have been successful in bringing these facts to the fore. It is needless to mention, that these pioneer mathematicians played a very important role in the context of Calcutta University.

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Abbreviations :

JASB : Journal of the Asiatic Society of Bengal,
PASB : Proceedings of the Asiatic Society of Bengal,
MA : Mathematical Annals,
CJ : Crelle's Journal,
BCMS : Bulletin of the Calcutta Mathematical Society,
S : Sankhya (Indian Journal of Statistics),
PRSL : Proceedings of the Royal Society of London.

Sir Asutosh Mookerjee—The Legend (Part-I)

Asutosh Mookerjee was a well-known educationist, a peer-less Vice-Chancellor, an eminent lawyer, a superlative judge and a brilliant mathematician. In the present article, we primarily wish to discuss his contributions as a mathematician. But that discourse needs to be divided into three parts. In the first section, we shall briefly identify the forces which indirectly helped Sir Mookerjee to almost singlehandedly usher in the era of western mathematics in the University of Calcutta. In the second section, we shall try to assess his personal contributions as a pioneer researcher of mathematics at a time when original research of any kind was practically unknown in India. In the final section, we shall try to portray his role as maker of mathematicians.

It is well-known that during the Gupta era, India had a very dominant intellectual status and was acclaimed as a centre of excellent academic activities. But after the thirteenth century, gradually, the country lost its academic eminence and excellence. At the end of the eighteenth century, the system of education in Bengal was absolutely deplorable. There existed only "Toles", "Maktabs" and "Pathsalas" which taught rudimentary Sanskrit, Persian, Arabic and elementary mathematics which was necessary for practical use in day to day transactions. The noted historian Dr. R.C. Majumdar very rightly said "While the world outside had made rapid progress in different branches of secular learning during the preceeding two hundred years, India practically stood still where it was six hundred years ago". Briefly, it may be commented that the system of education in India as a whole, as well as in Bengal gives a very dismal picture.

In the intellectual history of this country, later half of the eighteenth century was perhaps the darkest age. But as another noted historian Nemai Sadhan Bose has pointed out "The nineteenth century is one of the brightest periods in the history of India. In fact, it was the period that saw the birth of Modern India and the beginning of a series of thoughts and movements of far-reaching consequences".

In the backdrop of such a scenario, it is necessary to find out, what were the forces, which ushered in the modern era of mathematics in Calcutta. We have to also investigate the societal reactions and identify the path through which the two departments of mathematics in the University of Calcutta became such famous centres of modern western mathematics. What were the catalysts in the form of scientific movements than brought in a kind of renaissance in the world of mathematics in Calcutta.

To look into these reasons, one has to take into account the general situation in the nineteenth century society of Bengal. The introduction of English education was one of the main contributing factors in the progressivism in the field of education including mathematics. As Nemai Sadhan Bose points out "the English educated intelligentsia, the influence of growing urbanism and new education made the growth of progressivism inevitable".

But. the journey was not a smooth sailing. The intense ideological conflict between western modernism, liberalism and oriental tradionalism and conservation is really phenomenal in the history of nineteenth century Bengal. This controversy heightened in 1923, when the ruling

British Government proposed to establish a Sanskrit College in Calcutta. The great educationist, Raja Rammohan Roy wrote a memorable letter to Lord Amherst, rejecting the governmental decision and forcefully advocated in favcur of scientific education. His letter of 11th December, 1823 to Lord Amherst is the first milestone in the quest for scientific education in the country and hence deserves to be quoted. He wrote in an eloquent appeal to the government to "promote a more liberal and enlightened system of instruction embracing mathematics, natural philosophy, chemistry and anatomy with other useful sciences which may be accomplished with the sum proposed by employing a few gentlemen of talent and learning educated in Europe, and providing a college furnished with the necessary books, instruments and other apparatus."

His request was largely ignored by the government.

The foundation of the Hindu College in Calcutta was a landmark in the history of education in Bengal. Rejecting the attempts of orientalists as well as missionaries, the new English trained intelligentsia, who were the elites of nineteenth century Bengal, established in 1817, without any government assistance the Hindu College in Calcutta. This was the first institution founded for the purpose of spreading and cultivating a knowledge of "European literature and European Science". The college became immensely popular and by 1928 the enrollment figure of Hindu College rose to 400. Inspired by the success of Hindu College, several other colleges were started in Calcutta as well in some other small towns of Bengal. The exposure to European Sciences greatly attracted the elites of Bengal. In 1923 the British India Society of London donated scientific equipment to Hindu College for teaching astronomy, optics, mechanics and chemistry. In 1827, when Hindu College in its curriculum introduced mechanics, hydrostatics, optics, astronomy, mathematics etc, half of its enrolled students opted to study these subjects. Gradually mathematics and science classes were started in Calcutta Madrassah and in the Sanskrit College too.

In the report for the year 1835, the general committee of public instruction expressed satisfaction at the good reception of Indian pupils to European science and mathematics and suggested the establishment at each institution of a professorship of mathematics and natural philosophy. In the early part of nineteenth century, many Indian intellectuals also wanted western science to be introduced in the curriculum. Needless to say Raja Rammohon Roy was the greatest champion of modern scientific and mathematics education in the country. In Calcutta the situation was brimming with enthusiasm. Several societies like Native, School book Society, Society for the Acquisition of General Knowledge, Academic Association, "Tattabodhini Sabha" etc were set up. The aims of these societies were primarily to spread awareness about European education amongst the general public.

The first three universities in India, those of Calcutta, Bombay and Madras came into existence by an Act in 1857 and they were run entirely under the control of the British ruled government of India. The decision to establish the three universities was a shrewd and calculated diplomatic manoeuvre of the British rulers. The colonial power had no intention of doing a public service to the people of India. They wanted to train up people and make them proficient in English language so that they were able to work in the administrative machinery.

Another aspect has to be remembered. The three universities were created mainly for holding examinations and conferring degrees. The actual work of educating the students was left to the several colleges and schools affiliated to it. As a consequence, the University of Calcutta started functioning with seven Government and six private colleges affiliated to it. The names of the Institutions are given below :

Government Colleges :

Presidency College (earlier known as Hindu College), Calcutta Medical, College, Calcutta Civil Engineering College, Hooghlie College, Dacca College, Krishnanagar College and Baharampore College.

Private Colleges

Doveton College, St. Paul School, Free Church Institution, London Missionary Institution and Serampore College.

Initially Calcutta University had introduced Mathematics and Natural Sciences for the entrance examination. It was largely due to the efforts of father Lafont of St. Xavier's College, the D.P.I Alexander Pedler and Dr. Mahendralal Sircar, that an alternative B course in science was adopted by the senate of Calcutta University. The "A" course was purely literary while the "B" course had Mathematics, Inorganic Chemistry, Geography and English as compulsory papers and one optional paper out of Physics, Zoology, Botany and Geology. However, till then the Calcutta University, not being a teaching university did not have any provision for teaching in the post-graduate level. In Mathematics, both the Presidency College and the Scottish Church College had affiliation upto the post-graduate standard. However the syllabus followed was not really very up-to-date and the quality of teaching not very remarkable. Sir Asutosh Mookerjee had obtained his M.A. in Mathematics from the Presidency College. In his famous "Diary" he had profusely praised three of his mathematics teachers, namely Professor W. Booth, Professor J. McCann and Professor J.A. Martin but had his reservations about some of the other faculty members.

In the meantime there was growing resentment among the Indians owing to the preferential treatment meted out to Europeans by the colonial rulers mainly on racial grounds. This had twin effects on the Indian public. On the one hand it gave rise to greater demands for attaining self-reliance in scientific research and training. On the other hand it alienated the educated Indians from the British rulers and in the process helped the course of Indian Nationalism.

In 1869, Dr.. Mahendralal Sircar, a well known medical practitioner of the time wrote an article entitled "On the desirability of a national institution for the cultivation of Science by the natives of India". He wrote "We want an institution, which will combine character, the scope and objects of the Royal Institute of London and of the British Association for the Advancement of Science. We want an Institution which shall be for the instruction of masses.... And we wish that the Institution be entirely under native management and control". Dr. Sircar felt, that the main reason for the lack of development in the country was due to the backwardness of the Indians in Science. He was confident that Indians had the potential to master modern science.

After prolonged efforts and relentless perseverance, he finally succeeded in establishing in 1876, the "Indian Association for the Cultivation of Science" in Calcutta. It was founded with the money collected from public subscription. From the very beginning, Dr Sircar made a policy declaration that "basic sciences must be taught first before applied to the teaching of practical art". To implement this principle, lectures were arranged from 1885 on Mathematics, Physics, Chemistry and Biological Sciences. Along with the two founders Dr. M.L. Sircar and Father Lafont, other luminaries like J.C. Bose, Asutosh mookhedee, Syamadas Mukhopadhyay, Nilratan Sircar, Prasanna Roy, C.V. Raman (a later recruit) and others started taking classes in the Association. Asutosh mookherjee continued to deliver lectures in Mathematics in the Association till the end of 1890. We shall discuss these in greater detail later.

Patriotic educationists like Asutosh mookherjee were already fighting for securing a stronger foothold for science education.

The Indian Universities Act of 1904 was a very controversial act right from its initial stages. The commission appointed by the Governor General of India, Lord Curzon in 1902 was an all-white commission. Public opinion was strongly against a commission which was meant for reform of Indian Universities but which did not include a single Indian. In order to pacify the raging public sentiments, Gooroodas Banerjee, the first Indian Vice-Chancellor of Calcutta University was made a member of the commission. Asutosh Mookerjee was taken in as a co-opted member to act as a provincial representative educationist. As far as teaching functions were concerned, the Act of 1904 was merely a permissive one. Another great educationist, G.K. Gokhale feared that "this is just the part of the bill which would not come into operation".

On the 31st March 1906, Asutosh Mookerjee was appointed the Vice-Chancellor of Calcutta. Till that time, as Gokhale apprehended, nobody attached much importance to the clause in the bill enabling universities to conduct post graduate teaching. But Sir Asutosh Mookerjee, Vice-Chancellor of Calcutta University from 1906–1914, seized on this one section of the Universities Act and used it like a magic wand to convert the University of Calcutta into a great centre for teaching and research. At that time, because of historic events in the world scenario, Asian nationalism was awakening and India was no exception. In 1905, Curzon's decision to divide Bengal gave rise to tremendous popular resentment. Bengal and practically the whole of India was in open rebellion against the British rule Asutosh mookherjee was a child of the times. He worked relentlessly to bring about an intellectual regeneration and a nation-wide progress in education. This was his chosen tool. His lifelong mission was to raise the motherland to the glorious pedestal of intellectual supremacy.

From 1906 onwards, after taking up the charge of Calcutta University, as its Vice-Chancellor, Sir Asutosh Mookerjee began the towering career dedicated. to the service of his alma mater. He had in him a rare combination of wide and deep intellectual interests and superlative administrative ability and statesmanship. As the famous Hardinge Professor of Higher Mathematics, Professor R.N. Sen has stated "Inspite of many handicaps inherent in the Act of 1904 and against heavy odds, he carried the Senate with him to make plans, schemes and regulations for stimulating and spreading education in the country.....His crowning achievement was the creation in 1917 of the Post-Graduate Departments of Teachings in Arts and Science in the University which provided opportunity and incentive for higher study and research. To achieve all these objectives he was able to raise generous and princely donations and to attract the most learned and talented persons in science, humanities and letters from all over India to run the Post-Graduate Departments. The University was transformed from being merely an affiliating and examining institution into an organization with the added responsibility of disseminating and unfolding knowledge with the motto "Advancement of Learning".

In the backdrop of this unforgettable complement, one may roughly classify Sir Asutosh's challenging task into four stages:

1. Soon after taking charge of the university in 1906, Sir Asutosh Mookerjee in the first stage tried to arrange for instructions to be given to the M.A. students. through university lectures. They were mainly drawn from the faculty of affiliated colleges and well-known scholars of distinction.
2. In the second stage, he tried to establish University Chairs which were filled up by eminent academicians.
3. In the third stage, regular fulltime university professors, readers and lecturers were appointed. With huge monetary help received from Tarak Nath Palit and Rashbehari Ghosh, on March 27, 1914 Asutosh Mookerjee founded the University College of Science and Technology. This was the unveiling of new horizons aimed at enriching science and mathematics education in the country.
4. In the fourth and practically the final stage post-graduate study and research in Calcutta was centralized in the hands of the University and Post-Graduate departments of Arts and Science were established.

Along with faculties of other departments, in 1907, C.Little of Presidency College was appointed as a university lecturer in Mathematics. In 1909, the well-known mathematician and a professor of Presidency College, C.E. Cullis was appointed as university reader in Mathematics. In 1911, Syamadas Mukhopadhyay, also a professor of Presidency College was appointed as a university lecturer. In 1911, the chair of Hardinge Professor in Higher Mathematics was created. On August 8, 1913, Sir Rashbehari Ghosh, an eminent jurist and a noted scholar made a.generous gift of money to the University of Calcutta for the promotion of scientific and technical education and for the advancement of research in pure and applied sciences. According to the conditions of the endowment, four university professorships were to be created in different scientific disciplines, Applied Mathematics being one of them. Accordingly the Rashbehari Ghosh Professorship in Applied Mathematics was created. The newly created Mathematics department was bifurcated into two separate departments of Pure. Mathematics and Applied Mathematics. The first holder of the chair of Rashbehari Ghosh Professorship was an eminent Indian mathematician Dr. Ganesh Prasad and the first appointee to the Hardinge Professor's chair was a famous British mathematician, Prof. W.H. Young.

From the account given before the senate of the University of Calcutta on 27h September, 1913 by the then Vice-Chancellor Asutosh Mookerjee, it is revealed that in the Post-Graduate department of Pure Mathematics, there were 211 students and four full time lecturers. Professor W.H. Young, a Fellow of the Royal Society of England, was the Hardinge Professor of Pure Mathematics'. The four lecturers in the Department were Syamadas Mukhopadhyay, Haridas Bagchi, Indubhusan Brahmachari and Phanindranath Ganguly. They were all eminent mathematicians and were largely responsible for building up a good department of Pure Mathematics.

Apart from these whole-time faculty members, two other eminent mathematicians, who were university readers were also giving lectures on specified topics to post-graduate and advanced level students and initiating them to the world of original research in mathematical sciences. These eminent scholars were A.R. Forsyth and C.E. Cullis. Forsyth was giving lectures on Theory of Functions and Cullis was delivering special lectures on Determinoids.

The Department of Applied Mathematics started under the stewardship of Professor Ganesh Prasad, who joined as the Rashbehari Ghosh Professor of Mixed Mathematics (which later came to be known as the Department of Applied Mathematics) in 1914. Initially he was assisted by two of his research scholars, Dr. Sudhangshu Kumar Banerjee and Dr. Bibhuti Bhusan Datta,

The Post-Graduate Departments centralized higher study and research in mathematics and this was a step of far reaching significance and a period of Renaissance followed. Sir Asutosh was undoubtedly one of the masters of the school of modern scientific research in India. It was he, who almost single handedly initiated the spirit of modern western mathematics in the Calcutta University through its two departments. He carefully nurtured the departments as was his aim, which he had clearly spelt out while laying the foundation stone of the University College of Science and Technology in 1914. Sir Asutosh had said "I fervently hope that although the College of Science is an integral component part of the University of Calcutta, it will be regarded not as a provincial but an all-India College of Science to which students will flock from every corner of the Indian empire, attracted by the excellence of the instructions imparted and of the facilities provided for research."

Sir Asutosh Mookerjee—The Legend (Part-II)

As we have already mentioned earlier, Sir Asutosh Mookerjee was an outstanding mathematician. In spite of his earnest desire to devote his entire life to mathematical research, he could seriously conduct investigations in the subject only for a very brief period from 1884 to 1892. Still one has to remember that at that time original research in Mathematics was unthought of in this subcontinent. So Asutosh Mookerjee was in the true sense a pioneer mathematician and his role in building up the departments of Pure and Applied Mathematics of the University of Calcutta and his inspiration to contemporary and junior students of mathematics, makes him stand out as perhaps the greatest pioneer of his time.

Asutosh was the eldest son of Dr. Gangaprasad Mookerjee (1836-1889) and Jagattarini Devi (1848-1914) and he was born on the 29th June, 1864. His father was a well-known doctor and one of his uncles Radhika Prasad (1838-1894) was an executive engineer. Asutosh's father and uncles were first generation western educated professionals. It was a notable transformation from an orthodox Brahmin family of Sanskrit Pundits residing in a village (Jeerat) in Hooghly district of Bengal to a family of doctors and engineers shifted to and settled in Calcutta. So we may say that Asutosh Mookerjee was born in an educated Bengali family, and right from his childhood, he was exposed to an intellectual atmosphere at home. His real training was imparted by the father and the two uncles at home. His private tutors, Madhusudan Das, Pandit Panchanan Palodi and others were themselves great scholars and they built up the foundations of his future intellectual life. Asutosh Mookerjee lived in a traditional Bengali joint family and had a rather Spartan upbringing. His only source of joy was his immense passion for books, a passion which, was greatly encouraged by his father Gangaprasad Mookerjee. This intense love for reading books, lasted the whole of Sir Asutosh's life, and made him such a versatile man of letters. He also created the largest and most valuable personal collection of books (around 86000) in India, which his successors gifted to the National Library in 1949.

Asutosh was recognized as a child prodigy in Mathematics even by his school teachers. There are many anecdotes about his passion in handling numbers when he was just a young boy. To mention just one of these happenings would be interesting. Once as a boy, he was punished by his father for doing some mischief and was locked up in a room. Several hours later, when the door of the room was unbolted, it was found that Asutosh had worked out problems of mathematics all over the walls of that room with a mere piece of charcoal. Probably as a result of his father's direct care and supervision, in the formative period of his life, Asutosh imbibed a keen desire for learning. His strength of character was also a parental legacy.

After a bright school career, he joined the Presidency College, Calcutta and stood first in B.A. Mathematics in 1883. As is clear from his priceless 'Diary', which he started writing during his college years, as a student in the Presidency College, Asutosh used to read a lot outside his assigned curriculum. He read books on literature, philosophy, science and particularly on Mathematics. The notable fact is that, he hardly missed any new publication of a book by a famous mathematician. He was always very up-to-date in his studies in the subject. It is worth mentioning in this context, that he learnt both German and French during his college years, so that he could read the books and treatises as well as the research publications of the famous French and German mathematicians in the original.

His academic career was one of uniform brilliance. In 1885 he stood first in M.A. in Mathematics from Presidency College (affiliated to the University ersity of Calcutta). In 1886, he passed M.A. in the natural sciences, topping the list of successful candidates once again. He was the first student in the University of Calcutta, to obtain the Master's degree in more than one subject. In the same year, he was awarded the prestigious Premchand Roychand scholarship in Mathematics and Science on the result of a competitive examination.

In 1886 he was married to Jogmaya Devi (1872-1958). It was an arranged match. His father Dr. Gangaprasad Mookerjee took an unprecedented step in those times. He married off Asutosh without accepting any dowry. Socially conscious Asutosh was delighted with the decision.

Sir Asutosh was a versatile genius, but his main interest lay in the field of Mathematics. In this context, we would like to analyze the influences, which inspired him in this direction. Apart from his father and uncles, one of his father's great friend Dr. Mahendralal Sircar (1833-1904) was virtually a mentor of Asutosh Mookerjee. Mahendralal Sircar was the founder of the Indian Association for the Cultivation of Science,(1876). He and Father Lafont, a well known professor of Physics from St. Xavier's College, Calcutta, inspired Asutosh Mookerjee in the pursuit of Mathematics and Physics. Sir Asutosh's mentor and predecessor, Sir Gooroodas Banerjee, the first Indian Vice-Chancellor of Calcutta University was also a well-known student of Mathematics. He had tried very hard to procure a permanent post of a lecturer in Mathematics for Sir Asutosh in the University, but did not succeed. William Booth, John McCann and J.A.Martin were his teachers in Mathematics in Presidency College. These professors greatly inspired and encouraged young Asutosh in his study and pursuit of Higher Mathematics. These were some of the important influences, which largely contributed to the making of a mathematician in him. We are highlighting these points, because these are the forces, which emboldened Asutosh Mookerjee to venture into the untrodden paths of mathematical research single-handedly. Asutosh could not find a suitable person to guide him in his research work. Undaunted by the difficult situation, he still set forth and made very important contributions in the field of Mathematics.

During the twelve years from 1880 to 1892, Asutosh was on one hand preparing for and taking his B.A , M.A. and other examinations and on the other hand he was publishing original mathematical papers of high quality and merit. It is an amazing accomplishment, perhaps unparalleled in the history of Mathematics. At the age of 17, when Asutosh was only a first year student in Presidency College, he published his first research paper in Mathematics, entitled "On a Geometrical Theorem; Proof of Euclid I, 25" : [Messenger of Mathematics, Vol. 10, (1880-81) pp. 122-123]. In this paper he gave an elegant new proof of the 25th proposition of the first book of Euclid. In this context, it is worth mentioning, that while still an undergraduate student in Presidency College, Sir Asutosh was enamoured by various French Mathematicians.

He was greatly influenced by A.M. Legendre, G.Monge and others. They inspired him to take up studies in Geometry. Again as an undergraduate student, he published his second paper entitled "Extension of a Theorem of Salmon", [Messenger of Mathematics, Vol. 13, (1883-84)]. In this paper, he gave some extensions of a theorem enunciated by Salmon.

We also find from his "Diary", that Asutosh frequently mentioned the name of another great French Mathematician J.L. Lagrange. Clearly, he was fascinated by the mathematical expositions of Lagrange and probably that is what influenced him to take up elliptic functions as an area of research. While still a student of the fifth year M.Sc. class, he wrote his third paper entitled "A note on Elliptic Functions" [Q. Journ. of Pure and Appld. Maths, Vol. 21, (1886), pp. 212-217]. Clearly, the treatises of Lagrange named "Theorie des Functions Analytiques" (1797). and "Lecon Sur Le Calculus des Functions", (1804) and the works of A.M. Legendre (1752-1833) formed the base of Asutosh's research on elliptic functions. This was an outstanding contribution. In this paper he established a certain addition theorem in the theory of elliptic functions using a new method which utilised the properties of the ellipse. The well known British mathematician Prof. A.Cayley (1821-1895) after reading Asutosh's third paper had observed that the paper was remarkable because in it a real result was obtained by consideration of an imaginary point. Enneper in "Elliptische Funktionen" has referred to this paper. Later on Asutosh Mookerjee again wrote two papers where the elliptic functions were applied to the problems of Mean Values. The papers entitled "Some Applications of Elliptic Functions to problems of Mean Values, First and Second papers" [Journ. Asiatic Soc. Bengal., Vol. 58, Pt II, No. 2 (1889), pp. 199-213, pp. 213-231] are two such important publications.

Influenced by G. Monge, Asutosh began doing research by coupling geometry and calculus and this resulted in several very important publications. They may be listed as follows:-

1. "On the differential equation of a trajectory".[Jour. Asia. Soc. Bengal, 1887, 56, pp. 117-120].
2. "A memoir on plane analytical geometry". [Jour. Asia. Soc. Bengal, 1887, 56, pp. 288-349].
3. "A general theorem on the differential equations of trajectories", [Jour. Asia. Soc. Bengal, 1888, 57, 72-99].
4. "Remarks on Monge's differential equations to all conics", [Proc. Asia. Soc. Bengal, February, 1888].
5. "The geometric interpretation of Monge's differential equations to all conics", [Jour. Asia. Soc. Bengal, 1889, 58, 181-185].
6. "On the differential equation of all parabolas", [Jour. Asia. Soc. Bengal, 1888, 57, pp. 316-332].
7. "In a curve of aberrancy", [Jour. Asia. Soc. Bengal, 1890, 59, 61-63].

In the first of these papers, Asutosh considered the solution of the differential equation of oblique trajectory of confocal ellipses as given by the Italian mathematician Mainardi. This solution being extremely complicated and cumbersome, it was impossible to trace the curve from

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it. Asutosh showed by an ingenious process that Mainardi's inelegant solution could be replaced by a pair of remarkably simple equations. From this, interesting geometrical interpretations could also be made. These elegant equations as established by Sir Asutosh have been incorporated by Prof. A.R.Forsyth (1858-1942) in his classical book on Differential Equations, in latter editions. Enthused by the success of solving the problem on a particular trajectory so elegantly, Asutosh published another paper (the third paper in the above mentioned set of papers) on general trajectory. This paper amply displays Sir Asutosh Mookerjee's power of generalization and elegant expression. As is well-known, Asutosh Mookerjee pointed out that, he had to examine whether a proposed interpretation of a given differential equation is relevant or not, viz,

"Firstly, the interpretation must give a property of the curve whose differential equation we are interpreting; in fact, it must be a geometrical quantity which vanishes at every point of every curve of the system.

Secondly, the geometrical quantity must be adequately represented in the differential equation to be interpreted."

It is noteworthy, that without any guidance from anywhere, depending exclusively on his own brilliant mind. Asutosh successfully gave geometrical interpretation of Monge's Differential Equation to all conics. His interpretation was that "the radius of curvature of the aberrancy curve vanishes at every point of every conic".

Edwards in his book "Differential Calculus" has quoted this interpretation.

It may also be noted that Asutosh Mookedee's papers roused a lot of interest among a section of mathematicians. In a letter written to Sir Asutosh from Cambridge, dated 14th September, 1887, A. Cayley in a way supported Asutosh's criticism of J.J. Sylvester's interpretation of the Mongian and wrote "it is of course all perfectly right". Col. Cunningham wrote "Professor Asutosh Mukhopadhyay has proposed a really excellent mode of geometric interpretation of differential equation in general..."

Asutosh Mookerjee kept himself very well informed about the British School of Mathematics and he acknowledged the professional support he received from British mathematicians. A. Cayley (1821-1895) and J.J. Sylvester (1814-1897) were very helpful to Asutosh Mookerjee in the professional field.

But the research conducted by the French School of Mathematics, specially those with geometrical leanings were very close to his heart. S D. Poisson (1781-1840) was a notable mathematician of France who made very useful contributions in the field of theoretical Mechanics. His methods of integration gave alternative forms of differential equations. From Sir Asutosh's "Diary" we find that he read two of Poisson's books "Theorie Mathematique de la Chateur" (1835) and "Nouvelle Theorie de L'action Capillarie" (1831) very extensively. Clearly that inspired him to look closely into Poisson's work and specially his stand regarding analytic and synthetic approaches to Geometry. While evaluating the well known Poisson's integral which was first considered by S.D. Poisson in his memoir "Suite du Memoire Sur Les Integrales Definies" using a technique different from what Poisson did, Asutosh Mookerjee actually obtained a formula of transformation. This method also had the advantage of showing how the indefinite integral itself may be evaluated. In this process of evaluation, he arrived, at a symbolic value of Π. With his well-known love for geometry, in this paper also Asutosh Mookerjee tried to give geometric interpretation to calculus. It may be mentioned in this connection that the paper entitled "On Poisson's Integral" [Journ. Asia. Soc. Bengal, 1888, 57, 100-106] is a remarkable contribution.

The general impression about Sir Asutosh, the mathematician is that he was obsessed with Calculus and Geometry. But the myth is not acceptable because of the following two publications by Sir Asutosh Mookerjee. They are

1) "On Clebsch's Transformation of the Hydrokinetic Equations" [J . Asia. Soc. Bengal, 1890, 59, pp. 56-59].
2) "Note on Stoke's Theorem and Hydrokinetic Circulation" [J . Asia. Soc. Bengal, 1890, 59, pp. 59-61].

These are research papers on Fluid Mechanics, a very important branch of Applied Mathematics. Asutosh Mookerjee's interest in physical phenomena led him to the serious study of the works of the German mathematician R.F.A. Clebsch (1833-1872). Clebsch made important contributions in the general theory of curves and surfaces, their uses in Geometry, in the theory of invariants and in elliptic functions. The theories that he developed, were applied by him to various physical problems. Asutosh was greatly impressed by such exercise and was drawn to Hydrokinetics.

In his student days in Presidency College, Asutosh Mookerjee had already read the classical treatise of fluid dynamics by H, Lamb, namely "A treatise on the Mathematical Theory of Motion of Fluids". So in the paper entitled "On Clebsch's transformation of the hydrokinetic equations", [Journ. Asiatic Soc. Beng., Vol. 59, pt. II, No: 1. (1890), pp. 56 59], he considered hydrokinetic equations in the three cases:

i. irrotational motion,
ii. steady rotational motion and
iii. general rotational motion.

He demonstrated how the method of Clebsch's transformation to the third case may be simplified. In the second paper of this series, entitled "Note on Stoke's theorem and hydrokinetic circulation" [Journ. Asiatic Soc. Beng., Vol. 59. pt. II, No: 1 (1890), pp. 59-61], Asutosh Mookerjee gave a new proof of Stoke's formula of hydrokinetic circulation using Clebsch's transformation. Incidentally, he himself has remarked. in the second of these papers, "It is worth noting that as no physical conception enters into the above proof, it holds good, whether we regard the theorem as a purely analytic one or as merely furnishing a formula for hydrokinetic circulation". Clearly, both the papers are more analytical in nature and his contributions in this regard are as remarkable as those of Clebsch.

Asutosh Mookerjee was a trendsetter and a pioneer mathematical researcher in the field of Fluid Mechanics. Later on B.B. Dutta, S.K. Banerji, N.R. Sen, N.N. Sen and many others followed in his footsteps. Sir Asutosh Mookerjee remained a very powerful influence on the young research students of those times.

He was a trendsetter in the field of research in Geometry as well. Inspired by Sir Asutosh Mookerjee, many young mathematicians of the early twentieth century took up research in various branches of Geometry. Notable among them are Dr. Syamadas Mukhopadhyay, Dr. R.C. Bose, Dr. Haridas Bagchi, Prof. R.N. Sen etc.

Asutosh Mookerjee had a unique mind, which could understand the front line developments in the Mathematical Sciences of those times. His strong grasp of Geometry and clear understanding of Analysis and Calculus gave him a very wide vision of contemporary Mathematics. He wrote a text book on conics which was very popular in those days, both amongst the students as well as teachers of Mathematics.

Even when he was extremely busy in legal or administrative profession, Asutosh kept himself well informed about the latest developments in Mathematics by reading the contemporary books and journals on the subject.

As Vice-Chancellor of Calcutta University, he commissioned Prof. W.H. Young, the then Hardinge Professor of Higher Mathematics of the same University to submit a report on the study of Mathematics in the important centers of learning of the European Continent. This demonstrates, Sir Asutosh's committment to keep the Mathematics courses of the University of Calcutta at par with their international counterparts.

For his original research in Mathematics, Sir Asutosh Mookerjee was honoured by many national and international academic bodies related to the subject. In 1885, at the age of 21 he was elected a Fellow of the Royal Astronomical Society of Edinburgh. In 1886, he was elected as a Fellow of the Edinburgh Royal Society. He also became a member of the Royal Asiatic Society and Bedford Association for the Improvement of Geometrical Teaching.

In 1887, Asutosh was appointed Honorary Professor of Mathematics at the Indian Association for the Cultivation of Science for two years. He delivered 30 lectures during those two years and covered topics on Physical Optics, Mathematical Physics and Pure Mathematics. His lectures were of exceptionally high standard. Many of the topics that he discussed under Physical Optics actually belong to the discipline of Mathematical Physics. However, Sir Asutosh introduced a new course of lectures dealing with Hydrokinetics and the Theory of Potential. These lectures too were titled Mathematical Physics. In Hydrokinetics, he taught Green's theorem and it's applications, equations of motion, equations of continuity, Vortex motion, Clebsch's transformation, current functions of Stoke's and Earnshaw, Weber's transformation, Cauchy's Integral, Lagrange's equations, Thomson's theorem, flow and circulation, Stoke's theorem, conjugate functions, unipolar stream lines, Helmholtz's Theorems, energy and potential of vortices, waves and wave motion in liquids.

In Theory of Potentials, Asutosh delivered lectures on general properties of potentials, surface. integrals, potential of shells and Green's functions. He also delivered lectures on definite integrals with special reference to their applications to the theory of conduction of heat and diffraction of light, functions of Bessel and Heine', Fourier's theorems and its applications in Physics, Spherical harmonics, co-efficients, and theories of elastic solids.

In Pure Mathematics, Asutosh Mookerjee delivered courses on analytic geometry, Boole's Theorem, Boole's theorems on linear transformations, asymptotes and eccentricity, theorems on central conics, non central conics, confocal conics and plane elliptic coordinates, theory of analytic functions, integration of algebraic functions, hyperbolic functions, Abel's theorem, Dirichlet's theorem, Gamma functions etc. The topics mentioned above, indicate that Asutosh as a teacher was very familiar with the frontline areas of mathematics and during his very brief tenure in the IACS, he had impressed the students with his commendable and deep knowledge of the different branches of Pure as well as Applied Mathematics. During that time he was also appointed examiner in Mathematics by the Calcutta University. In 1887, he was elected Fellow of the London Physical Society.

In 1890, as a recognition of his original contributions to Mathematics, he was made a Member of the Mathematical Society of Palermo, Sicilly and Societe de Physique of France.

In 1908, Sir Asutosh founded the Calcutta Mathematical Society and became its Founder President. He nurtured the society very carefully and ultimately the society became a great and vibrant centre which aided the future researchers of Mathematics a great deal. Asutosh Mookerjee, as the President of the Calcutta Mathematical Society guided the activities of the society from its inception till his own death in 1924. During Sir Asutosh's lifetime 83 meetings of the society (other than council meetings) were held and he presided over each one of these meetings. For a busy man like him, it was a rare feat indeed. Such was his dedication to the society. Under his personal initiative, encouragement and inspiration. research workers in mathematical and physical sciences began to gather around him. Of these scholars later on some became world renowned scientists. These young scholars delivered addresses on their research work before the Society and their contributions were published in the pages of the Bulletin of the Calcutta Mathematical Society. Just to give an idea about Asutosh Mookerjee's success in encouraging the talented mathematicians to come forth with their research contributions, it would be sufficient to state that in the first meeting of the Society in 1909 papers were read by Professor C.E. Cullis, Professor Ganesh Prasad, Professor S.D. Mukhopadhyay and Professor P.L. Ganguli. In 1914, B.B. Dutta presented his research work before the Society. In 1915, M.N. Saha and S.K. Banerji did the same. In 1916, S.N. Bose delivered an address on his research work followed by D.N. Mallik, N.R. Sen etc in 1917. The trend continued under the careful patronage of Asutosh Mookedee. All the pioneer mathematicians of Calcutta which included the above legendary names as well as the younger talents like B.M. Sen, N.N. Sen, J. Ghosh, G.. Bhar, B.B. Sen etc had their inspiration and encouragement from the greatest pioneer of mathematical research in the country, Sir Asutosh Mookedee.

One is amazed at Sir Asutosh's far sight. In the early twentieth century, he had realised the need for an academic society in Mathematics. He, the true pioneer of mathematical research in the country, left no stone unturned to leave a conducive environment of mathematical research for the future generation of scholars. Calcutta Mathematical Society was Sir Mookerjee's gift to the future generation of researchers in mathematical and physical sciences in this country.

Just to demonstrate, how Sir Asutosh Mookedee was regarded by some of the greatest Indians of those times, the following remarks are very noteworthy. Rabindranath Tagore, the greatest amongst Indian intellectuals wrote about Asutosh "He had the courage to dream because he had the power to fight and the confidence to win....his will itself was the path to the goal.' Regarding his contributions in the field of mathematical research, Dr. Ganesh Prasad wrote

"After Bhaskara he was the first Indian to enter into the field of Mathematical Research as distinguished from Astronomical Research and much which was truly original". After Sir Asutosh Mookerjee suddenly passed away in Patna in 1924 at the age of sixty, Nobel Laureate Sir C.V. Raman lamented and said that Bengal in gaining a distinguished Judge and a great Vice-Chancellor lost in him a still greater Mathematician.

Complete List of Publications of Sir Asutosh Mookeriee

1. Proof of Euclid I, 25 : [MM, 10, (1880-1881), 122-123]
2. Extension of a theorem of Salmon's : [MM, 13 (1883-1884), 157-160]
3. A note on Elliptic Functions . [QJPAM, 21, (1886), 212-217]
4. On the differential equation of a trajectory : [JASB, 56, Pt. II, No. 1, (1887), 117-120]
5. On Monge's differential equation to all conics JASB, 56, Pt. II, No. 2, (1887), 134-145]
6. A memoir on plane analytical geometry : [JASB, 56, Pt. II, No. 3, (1887), 288-349]
7. A general theorem on the differential equations of all trajectories: [JASB, 57, Pt. II, No. 1, (1888), 72-99]
8. On Poisson's integral : [JASB, 57, Pt. II, No. 1, (1888). 100-106]
9. On the differential equations of all parabolas : [JASB, 57, Pt. II, No. 4, (1888), 316-332]
10. Remarks on Monge's differential equation to all conics : [PASS, February, (1888)]
11. The geometric interpretation of Monge's differential equations to all conics [JASB, 58, Pt. II, (1889) 181-186]
12. Some applications of elliptic functions to problems of Mean Values (First paper) . [JASB, 58, Pt. II, No. 2, (1889), 199-213]
13. Some applications of elliptic functions to problems of Mean Values (Second paper). [JASB, 58, Pt. II, No. 2, (1889), 213-231]

14 On Clebsch's transformation of the hydrokinetic equations . [JASB, 59, Pt. H, No. 1, (1890), 56-59]

15. Note on Stoke's theorem and hydrokinetic circulation : [JASB, 59, Pt. II, No. 1, (1890), 59-61]
16. On a curve of aberrancy : [JASB, 59, Pt. II, No. 1, (1890), 61-63]
17. Mathematical Notes (Questions and Solutions) . [ET, London, 43, 44, 45, (1890-1892), 125-151, 144-182 146-168]

Abbreviations and the Names of Journals.:

1. ET - Educational Times
2. JASB - Journal of the Asiatic Society of Bengal
3. MM - Messenger of Mathematics
4. PASB - Proceedings of the Asiatic Society of Bengal
5. QJPAM—Quarterly Journal of Pure and Applied Mathematics.

Dr. Ganesh Prasad (1876-1935)

Ganesh Prasad was born on the 15th November, 1876 at Ballia, U.P. He belonged to a well-to-do family. After passing his matriculation examination in 1891 with a first division, he studied at the Muir College, Allahabad. From there he graduated with a first class honours in Mathematics in 1895. Subsequently, he took M.A. degrees in Mathematics from the Universities of Allahabad and Calcutta and in 1898 was awarded the D.Sc. degree from the Allahabad University for his original contributions in mathematical research. After a brief stint as lecturer at the Kayasth Pathshala, Allahabad, in 1899 he obtained a Government of India scholarship to go to England for pursuing higher studies and research in Mathematics.

While at Cambridge, Ganesh Prasad sat for the Adam's Prize competition. For this he had submitted his original research paper entitled "On the Constitution of Matter and Analytical Theories of Heat". But that year no one was awarded the prize.

So Ganesh Prasad moved on to Göttingen in Germany and showed his research paper to the famous German mathematician Professor Felix Klein. Professor Klein was much impressed by the work and got the paper published in the Góttingen Abhandlungen* During his stay at Cambridge, Ganesh Prasad had famous mathematicians like Ernest Hobson, A.R.Forsyth, Allan Baker and Lamour as his contemporaries. While carrying out research in Göttingen University, Ganesh Prasad came into close contact with men like A.J.Sommerfeld, David Hilbert and Georg Cantor.

During his stay in Göttingen, Ganesh Prasad solved another important problem and wrote it down as a mathematical research paper entitled "On the Notion of Lines of Curvature" and showed it to Professor D. Hilbert. Professor Hilbert was quite impressed with Dr. Prasad's method of solution and immediately communicated it to the Royal Society of Sciences of Gottingen. This paper was published in the "Proceedings of the Royal Society of Gottingen" in 1904.

After five very fruitful years of study and research abroad, Dr. Ganesh Prasad returned to India in 1904. On his return , he was appointed additional professor of mathematics at the Muir Central College, Allahabad. In 1905, Pandit Sudhakar Dwivedi, the then Head of the Department of Mathematics at the Queen's College, Banaras retired and Dr. Ganesh Prasad had to take up responsibilities there. Being the only faculty member in the department, he had to teach in all the four degree classes singlehandedly. But even at that young age and with so much of teaching load, Dr. Ganesh Prasad found time to help two students in preparing for their D.Sc. degree. This clearly indicates Dr. Ganesh Prasad's great love for mathematical research. This point will be discussed in greater detail and highlighted later.

We have mentioned earlier, that Sir Asutosh Mookerjee kept himself well informed about contemporary mathematical research. Obviously Ganesh Prasad's achievements in mathematical research and his publications in scientific journals had caught the attention of Sir Asutosh, who was then the Vice-Chancellor of Calcutta University. He was just setting up the post-graduate departments of Pure and Mixed Mathematics in the University of Calcutta. So Sir Asutosh lost no time and in 1914, Dr. Ganesh Prasad was invited to become the first Rashbehary Ghosh Professor in the Department of Mixed Mathematics, which later on came to be known as the Department of Applied Mathematics. For four years Dr. Prasad served the University of Calcutta but in 1917, he returned to Banaras as a professor of mathematics in the Banaras Hindu University and honorary Principal of the Central Hindu College, Banaras. After six years, in 1923, he was once again invited by Sir Asutosh Mookerjee to take up the Hardinge Professorship of Higher Mathematics in the Department of Pure Mathematics. Dr. Ganesh Prasad continued in this post till his death on the 9th March, 1935.

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* "Constitution of Matters and Analytical Theories of Heat" . Abhandlungen d k Geselschaft der Wiss Zu Gottingen, 1903.

This great mathematician enhanced the prestige of Calcutta University in two ways. Firstly his personal research contributions in Mathematics are legendary. He was the author of a fairly large number of research paper, memoirs and reviews. Dr. Ganesh Prasad's research work can be roughly classified into three main groups. The first group consists of papers on Applied Mathematics, specially in the theory of potentials. In this field, Ganesh Prasad used his knowledge of the theory of functions of a real variable. The researchers prior to him had not considered the cases, in which, under special circumstances, the differential coefficients either became infinite or did not exist. Dr. Ganesh Prasad made a thorough investigation of such cases. A noteworthy contribution to this group was the memoir entitled "Constitution of Matter and Analytical Theories of Heat" [Abk. Gott., 2, 1903].

The second group consists of research papers on the theory of function of a real variable, the thrust being mainly on Fourier Series. The work in this area constitutes the bulk of his research work. He has written out a number of results concerning the summability and strong summability of Fourier Series. Most of his work in this field is based on a special type of functions having discontinuities of the second kind. He also delivered a series of six lectures on the researches in the theory of Fourier Series. In 1928, the University of Calcutta published these lectures in the form of a book entitled "Six lectures on Recent Researches in the Theory of Fourier Series" [by Dr. Ganesh Prasad]. In this book, he has discussed in details the convergence problem of Fourier Series. It may be noted that Ganesh Prasad made a valuable publication "On the summability (C1) of the Fourier Series of a function at a point where the function has an infinite discontinuity of the second kind" [BCMS, 19 51-58].

His third group of papers are those on spherical harmonics* and Legendre's function. Dr. Prasad has given an interesting theorem, using which an arbitrary function can easily be expressed as a sum of surface harmonics (Vide Hobson, Theory of Spherical and Ellipsoidal Harmonics, pp. 148). In this group, his book entitled "A Treatise on Spherical Harmonics and the Functions of Bessel and Lame" is treated as a classic work in mathematics.

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* The spherical harmonics are the angular portion of the solution to *Laplace's equation in spherical coordinates* where azimuthal symmetry is not present.

The most remarkable fact about Dr. Ganesh Prasad's research work was that he always took up challenging problems in areas which were very relevant in those times. He himself worked in such areas and motivated his research students to further investigate the associated problems.

To elucidate the point, we shall take up a case or two. For example, in the context of his paper entitled "On the fundamental theorem of the Integral Calculus for Lebesgue Integrals" [BCMS, 16(1926) 109-116], the following features are noteworthy. In two of his earlier papers namely "On the fundamental theorem of Integral Calculus" [BCMS, 15 (1-4) 1924-25] and "On the fundamental theorem of the Integral Calculus in the case of Repeated Integrals" [BCMS, 16 (1926) 1-8] he had studied the problems of

(1) deciding if the differential coefficient of the Riemann indefinite integral of a function having a discontinuity of the *second kind* at a point in the region of integration, exists at that point or not and

(2) finding the value in the former event, that is if it exists.

After these calculations, his objective in the third paper was to show, by selected examples, that for the Lebesgue integral of a function, whose discontinuities were of the second kind, many features present themselves during the course of the solution of the problem which were similar to those found in the papers referred to earlier, although the function was not integrable according to Riemann's definition.

Historically, it may be noted that the first serious contribution to the study of the problem was the paper entitled "Uber die differenzirbarkeit eines Integrales nach der oberen Grenze" [Nachrichten d Königlichen Gesellschaft der Wisseschaften zu Göttingen, (1893) 696-700]. The paper was communicated by late Prof. J. Thomae of Jena to the Royal Society of Göttingen in October, 1893. The introduction to the paper, translated into English would be "If $f(x)$ is a function integrable between the limits a and b and if for a value c of x between a and b, $f(c+0)$ does not exist", then the question that arises is whether, $\omega(x) = \int_a^x f(x)\,dx$, possesses a progressive differential coefficient at the point c or not. Since, in general, the progressive differential coefficient of $\omega(x)$ is equal to $f(x+0)$, it is natural to conclude that this differential coefficient does not exist at the point c. Thomae proved the above mentioned theorem by using Du Bois—Reymond's Second Mean Value Theorem.

In the well-known book entitled "Bericht Uben die Entwickelung der Lehre Von der Punktmannigfaltigkeiten" (Leipzig, 1900), Prof. A.Schoenflies devotes a whole chapter to the fundamental theorem of the Integral Calculus.

Prof. G. Prasad further suggested the following problem: "To classify non-differentiable functions according to the number of limiting points which its zeros possess in a finite interval".

S.K.Bhar was encouraged by Ganesh Prasad to carry out the investigation.

Dr. Ganesh Prasad's own research scholar Dr. Avadesh Narayan Singh had published two original research papers in this area under the guidance of Prof. Prasad.

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In the first paper Dr. Singh had defined a class of Non-differentiable functions which was published in the "Annals of Mathematics", [28(1927) 472-476].

In the second paper of the series entitled "On the unenumerable zero's of Singh's Non-differentiable functions" [BCMS, 22(1929) 91-102], Dr. A.N. Singh studied.the zeros of this class of functions and made useful conclusion.

Taking up a third example, we shall once again show the mastery of Dr. Ganesh Prasad as a research guide. As early as in 1915, Dr. Ganesh Prasad published a research paper entitled "On the existence of the mean differential coefficient of a continuous function" [BCMS, 3(1911-12) 53-54]. In this paper, Dr. Prasad raised a question and asked "Does there exist a continuous function which has no mean differential coefficient for any value of x?".

Encouraged by Ganesh Prasad, one of his students Santosh Kumar Bhar took up the problem. Dr.Prasad had in his own paper investigated the non-differentiable functions of Weirstrass, Darboux, Lerch, Fabex and Landsberg. He found that each of these functions has a set of points–everywhere dense, where the mean differential coefficients exists. S.K.Bhar carefully examined some of the non-differentiable functions, which had been discovered at that time, such as those of Steintz [Math. Ann. Bd. 52 (1892), 58-62], Peano [Math. Ann. Bd. 26], A.N.Singh [Annals of Math. 28 (1927). 472-476] and Hahn [Jahresber d.d Math Vereinigung, Bd. 26 (1918) 281-284] and came to identical conclusions. Thereafter S.K. Bhar took up some non-differentiable functions not investigated by G.. Prasad and ultimately discovered some important results in the case Dini's function [Annali di Mathematica, Ser. 2, t, 8 (1877)].

S.K. Bhar concluded that

I. Generally, the mean differential coefficient is non-existent. at every rational point in (0,1)
II. It is completely proved that in all cases of irrational numbers, the mean differential coefficient is non-existent.

Thus encouraged and inspired by Dr. Ganesh Prasad, S.K.Bhar published a notable research paper named "On a continuous function which has no mean differential coefficient for any value of x" [BCMS].

Dr. Ganesh Prasad had independently suggested the problem to one of his students Dr. Lakshmi Narayan. Without any previous knowledge of Thomae's results, L. Narayan built up a theory and called it "integration-image". However, Dr. Ganesh Prasad thought that the method of Dr. Lakshmi Narayan was not suitable for giving a general criterion. While going through the manuscript of Dr. L. Narayan's paper [which was published in the "PBMS" in the years 1924 and 1925], Dr. Ganesh Prasad became interested in the problem. He worked on all the three connected problems mentioned at the outset. The criteria given by him are believed to be simpler and more general than the criterion given by Thomae

Mr. J.M. Whittaker, a well-known British mathematician also became interested in the problem after reading Dr. Lakshmi Narayan's work. Later he communicated a paper entitled "The differentiation of an Indefinite Integral" [PEMS, 46(2) Nov. 1925].

This discussion clearly indicates, Dr. Prasad's exceptional talent in solving difficult mathematical problems and also his capacity to motivate other mathematicians to take up the associated unsolved problems.

Another research paper by Dr. Ganesh Prasad entitled "On the zeros of Weierstrass's non-differentiable function" [published in the "Proceedings of the Banaras Mathematical Society", 'XI(1930) 1-8] created lot of interest among many mathematicians of those times. Dr. Ganesh Prasad inspired many of his students to work in that area and at least three very good papers were published by his students. To exhibit Dr. Prasad's remarkable ability to guide, encourage and draw out the best from his students, we would like to cite some of the remarks made by the involved mathematicians.

Encouraged and helped by Dr. Ganesh Prasad, Professor Bholanath Mukhopadhyay published a paper entitled "On the limiting points of the zeros of a non-differentiable function first given by Dini" [Bulletin of the Calcutta Mathematical Society, XXII (2 and 3) (1930) 103-114], and in the introduction to his paper he writes "The publication of Dr. Ganesh Prasad's remarkable paper "On zeros bf Weierstrass's Non-differentiable functions" has naturally led mathematicians to study the zeros of different types of Non-differentiable functions.

Another-mathematician Santosh Kumar Bhar published a paper entitled "On the zeros of Non-differentiable functions of Darboux's type".

S.K. Bhar in the course of the paper wrote, "those who wished to give graphical representation of non-differentiable functions, as Weiner, Felix Klein and G.C.Young did in the case of Weierstrass's function, must have desired to know the zeros of the concerned function. However, it is only recently, that the first successful investigation of this type has been published by Dr. G. Prasad, who has given general expressions from which zeros of Weierstrass's function can be obtained".

His remarkable ability to inspire students produced a rich harvest of brilliant research papers in mathematics. Dr. Prasad inspired Nripendranath Ghosh and N.N. Ghosh wrote and published a paper entitled "On the calculation of the zeros of Legendre Polynomials" [BCMS, 21(1) (1929) 61-68].

Dr. G. Prasad encouraged and guided H.P. Banerjee to publish a paper entitled "On the summability (C,1) of Legendre series of a function at a point where the function has a discontinuity of the second kind".

The above examples demonstrate how very successfully, Ganesh Prasad motivated his students to take up challenging and important mathematical problems and solve them.

Apart from being a great teacher, a great researcher and a brilliant research guide, Dr. Prasad also wrote a number of articles on history of mathematics and published a well-known book on "The great Mathematicians of the Nineteenth Century". In this area also, he strongly influenced and inspired two of his students in Calcutta University—namely B.B. Datta and A.N. Singh to carry out serious research in the field of ancient Hindu and Jaina mathematics.

He built up two strong centres of mathematical research, one in the Department of Pure

Mathematics and the other in the Department of Applied Mathematics of Calcutta University. His role in the context of Calcutta University as a teacher, a fundamental researcher and as a remarkable research guide will always be remembered with awe and reverence. How could a single person contribute so much in those days in a country under foreign domination is really amazing. Dr. Ganesh Prasad's contributions in the context of Calcutta University will be recorded in golden letters in the annals of the university.

Dr. Prasad had oublished.about fifty research papers in national and international journals and a number of books. Here we shall selectively mention some of the more important ones.

Before actually writing down the list of Dr. Ganesh Prasad's publication, a comment regarding his mathematical style would not be out of place. Essentially, Dr. Prasad was an analyst. Simple and undiluted Arithmetisation was his favourite tool. In spirit, he was really the successor of Weirstrass, though in reality he was a favourite student of F. Klein. We give here a list of his more important publications, with some comments, when necessary.

1. "On the potential of Ellipsoids. of variable densities" [MM, 1901, 8]. [In this paper he 'has used the method of expansion in series. Actually this is indicative of his later works on summation theorem and asymptotic expansions. The most remarkable feature of this paper is that it furnishes an expansion of any algebraic integral functions in series of spherical harmonics. Since one is concerned with integral functions, knowledge about the singularities of the integrals is not necessary. In this paper, Dr. Prasad's method of getting round the improper behavior of certain parameters is quite remarkable. It applies to the expansion in any function space of any number of dimensions.]
2. "Constitution of matter and analytical theories of Heat" [Abhandulgen d.k., GWZG, 1903]. [This paper is considered as an authoratative solution of a difficult problem in mathematical physics. Felix Klein considered it as a very satisfactory solution].
3. "On the Notion of Lines of curvature" [PRSG, 1904].
4. "On the present state of the theory and applications of Fourier's Series" [BCMS, 2(1910-1911) 17-24].
5. "On Some Recent Researches relating to the Expansibility of Functions in Infinite Series" [BCMS, 2(1-2)(1910-11) 3-9].
6. "On the existence of the Mean Differential Co-efficient of a Continuous Function" [BCMS, 3(1911-1912) 53-54]
7. "Expansion of arbitrary functions in a series of spherical harmonics" [MA,1912]. [This is a very important result and has been quoted in Hobson's book entitled "Theory of Spherical and Ellipsoidal Harmonics, 148"].
8. "On a Non-Analytical potential function" [BCMS, 10(1-4)(1908-1913) 39-41].
9. "On the Foundations of the Theory of Surfaces" [BCMS, 10(1-4) (1908-1913) 131-133].
10. "On the linear distribution corresponding to the potential function with a prescribed boundary value" [BCMS, 5(1913-1914) 47-52].

11. "On. the Second Derivates of the Newtonian Potential due to a Volume Distribution having a Discontinuity of the second kind" [BCMS, 6(1914-1915) 3-11].
12. "On the Vibrating String with an Infinite Number of Edges" [BCMS, 7(1915-1916) 25-32].
13. "On the failure of Poission's equation and of Petrini's generalization" [BCMS, 8(1916 -1917) 33-39].
14. "On the normal derivative of the Newtonian Potential due to a surface distribution having a discontinuity of the second kind" [BCMS, 9(1917-1918) 1-9].
15. "On the Fundamental Theorem of the Integral Calculus [BCMS, 15(1- 4) (1924-1925) 57-68].
16. "On the fundamental theorem of the Integral Calculus for Lebesgue Integrals" [BCMS, 16(1926) 109-116].
17. "On the fundamental theorem of the Integral Calculus in the case of repeated integrals "[BCMS, 16(1926) 1-8].
18. "On the summability (C 1) of the Fourier Series of a function at a point where the function has an infinite discontinuity of the second kind" [BCMS, 19 (1926) 51-58]
19. "On the failure of Lebesgue's Criterion for the summability (C1) of the Fourier Series of a function at a point where the function has a discontinuity of the second kind" [BCMS, 19(1926) 1-12].
20. "On the summability (CI) of the derived series of the Fourier Series of an indefinite integral at a point where the integrand has a discontinuity of the second kind" [BCMS, XIX. (1926) 95-100].
21. "On the strong summability (C1) of the Fourier Series of a function at a point where the function has an infinite discontinuity of the second kind" [BCMS, 19 (1926) 127-134].
22. "On the failure of Lebesgue's Criterion for the summability (C2) of the Fourier Series of a function at a point where the function has a certain type of discontinuity of the second kind" [BCMS, 19(1926) 25-28].
23. "On the function—in the Mean-Value Theorem of the differential calculus" [BCMS, XX (1927) 155-184].
24. "On the differentiability of the integral function" [CJ, Vol. 160, 1929]. [According to mathematicians of the time it was an epoch making publication].
25. "On Roll's function as multiple-valued function" [PBMS, Vol. X 21929].
26. "On the Summation of Infinite Series of Legendre's Functions" [BCMS, 22(4)(1930) 159-170].
27. "On the zeros of Weierstrass's non differentiable function" [PBMS, XI(1930) 1-8].
28. "On the nature of o in the mean-value theorem of the Differential Calculus" [BAMS, Vol. 36, 1930].
29. "On the Summation of Infinite Series of Legendre's Functions(second paper)" [BCMS, 23(4)(1930) 115-124].

30. "On the determination of f(h) corresponding to a given Rolle's function θ(h) when it is multiple-valued" [PBMS, Vol. XII, 1931].
31. "On non-orthogonal systems of Legendre's functions" [PBMS,Vol. XII, 1931].
32. "On the differentiability of the indefinite integral and certain summability criteria" [Address delivered in 1932 to Mathematical and Physical section of Science Congress].
33. "On the Lebesgue's integral mean-value for a function having a discontinuity of the second kind" [PBMS, Vol. XIV, 1933].
34. "On Lesbegue's absolute integral mean-value for a function having a discontinuity of the second kind" [Special memorial volume of the Tohoku Mathematical Journal in honour of Professor Hayashi, 1933].
35. "Hobson, Presidencial address on the life and works of the late Professor Hobson" [BCMS, Vol. 25, 1933].
36. Review : Lebesguesche Integrals and Fouriersche Reihen. [BCMS, XVIL(4)(1926) 203-206].

Abbreviations:

1. BCMS - Bulletin of the Calcutta Mathematical Society
2. PBMS - Proceedings of the Benares Mathematical.Society
3. PEMS - Proceedings of the Edinburgh Mathematical Soc
4. MM - Messenger of Mathematics
5. GRZG - Geseischalf der Wiss Zu Gottingen
7. PRSG - Proceedings of the Royal Society of Gottingen
8. MA - Math. Ann.
9. CJ - Crelle's J.
10. BAMS - Bull. of the American Mathematical Soc.

Important Books written by Dr. Ganesh Prasad

1. Differential Calculus (1909)
2. Integral Calculus (1910)
3. An Introduction to Elliptic function (1928)
4. A treatise on Spherical Harmonics and the Functions of Bessel and Lame (1930- 32)
5. Six lectures on recent researches in the theories of Fourier Series (1928)
6. Six lectures on recent researches about mean-value theorem of the Differential Calculus

On History of Science

7. Mathematical Physics and Differential Equations at the beginning of the 20th century
8. Some great mathematicians of the 19th century (2 volumes)

Syamadas Mukhopadhyay (1866-1937)

Syamadas Mukhopadhyay was born at Haripal in the Hooghly district of West Bengal on the 22nd June 1866. He obtained his M.A. degree in Mathematics from the Presidency College, Calcutta. He started his teaching career at Bangabasi College, Calcutta. He later took up government service and taught at Bethune College, Hooghly Mohsin College and Presidency College, Calcutta. It may be noted that S.D. Mukhopadhyay was the first Indian to obtain a doctorate degree in Mathematics in India. He obtained his Ph.D degree from the University of Calcutta in 1910. He was also awarded the Griffith Memorial Prize in the same year. As we have repeatedly mentioned, Sir Asutosh Mookerjee always kept himself well-informed about brilliant young scholars. Syamadas Mukhopadhyay was definitely one such exceptionally talented mathematician. Though we have been unable to obtain any concrete proof, but there is a general belief, prevalent in the mathematicians circle in Calcutta, that it was Sir Asutosh Mookerjee who inspired and encouraged Syamadas Mukhopadhyay to take up research in Geometry. In one of his papers entitled "On Rates of Variation of the Osculating Conic" [Published in the Bulletin of the Calcutta Mathematical Society, Vol. 1, No. 2, PP 125-130, 1909 (July)] Syamadas Mukhopadhyay has referred to a paper by Sir Asutosh Mookerjee entitled "The Geometric interpretation of Monge's differential equation to all conics" [Vide—J. Asiatic Soc. of Bengal, Vol. LVIII, part II, No. 2, PP. 181-185, 1889] and has commented that "Professor A. Mukhopadhyay has based an elegant interpretation of the differential equation of the general conic". Sir Asutosh Mookerjee, as Vice Chancellor of Calcutta University appointed Syamadas Mukhopadhyay as a lecturer in the newly formed department of Pure Mathematics in 1911.

Dr. S.D. Mukhopadhyay made ade outstanding contributions in the field of Geometry. As remarked by another great Pure Mathematician of Calcutta University Professor M.C. Chaki. "His contributions in geometry stand out prominently on account of their novelty and originality".

Dr. S.D. Mukhopadhyay's research work may be broadly classified into three parts. In the first part, we place his researches dealing synthetically with properties of a plane curve, specially in infinitesimal regions. Here he developed new methods. These methods led to a number of interesting theorems on the existence of cyclic and sextactic points on a convex oval. The theorem which states that the minimum number of cyclic points on a convex oval is four, is now well known and is referred to in geometry as Mukhopadhyay's "Four Vertex Theorem". The proof of this celebrated theorem was published in the Bulletin of the Calcutta Mathematical Society in Vol. 1,. 1909. ["New methods in the Geometry of a Plane Arc, 1. Cyclic and Sextactic Points", B.C.M.S., Vol. I., PP. 31-37, 1909].

His series of papers in this context are listed in the complete bibliography given at the end of this chapter and are numbered in chronological order. Papers [4 to 7] dealing with these methods of analytical geometry were all published in the Bulletin of the Calcutta Mathematical Society Vol. 1, 1909. These new methods developed by Professor S.D. Mukhopadhyay aroused a good deal of interest among some famous mathematicians of the time. Professor Hadamard referred to his work in the memoirs of College de France. Professor W.Blaschke gave credit to Dr. Mukhopadhyay for giving the first proof of the celebrated "Four Vertex Theorem". Professor Engel also showed much interest in these developments.

The second part of the research work belongs to the field of plane Hyperbolic Geometry. The third and final part of his research work deals with Differential Geometry of curves. For space curves of n dimensions, Professor Mukhopadhyay introduced certain differential forms. He called them "Parametric Coefficients" and using these he expressed many invariant properties of curves.

He suggested a stereoscopic device for visualising in 4-dimensional space. He wrote a paper entitled "A Note on the Stereoscopic Representation of Four Dimensional Space", which was published in 1912 in the Bulletin of the Calcutta Mathematical Society.. Professor Bryan criticised the work and Professor Mukhopadhyay published a "Reply to Professor Bryan's criticism" which was published in 1914. in the Bulletin of the Calcutta Mathematical Society.

The complete list of his publications is given at the end of this article. We shall now selectively discuss a few of his research papers and try to assess its impact in the cotemporary mathematical scenario.

If we take up the paper no [7] from the list, the title of the paper is self-explanatory. The title is "Parametric Coefficients in the Differential Geometry of curves in an N-space. 11, Extension of Serret Frenet Formulae to curves in an N-dimensional space". Bull. Cal. Math. Soc. Vol. I , No. 4, PP. 233-243, January 1909]

In this context, we would like the attention to the fact that Professor J.G. Hardy, in the American Journal of Mathematics, Vol. XXIV, page 4, deduces extensions of Serret Frenet's Formulae to curves in four dimensional space. His results come out in slightly different and less simple forms, as he did not conceive principal curvatures.

In the paper entitled "Geometrical Investigations on the correspondence between a right-angled triangle a three right angled quadrilateral and a rectangular pentagon in Hyperbolic Geometry" [Bull. Cal. Math. Soc. Vol. XIII, No. 4, PP. 211-216, 1922-23], Professor Mukhopadhyay established an important result and he concluded "We have thus the closed series of 5 associated right-angled triangles and the Engel-Napier Rules are shown to possess a real geometrical basis in the rectangular pentagon".

In 1926, with the publication of the paper entitled "On General Theorems of Co-intimacy of symmetries of a Hyperbolic Triad" [Bull. Cal. Math. Soc. Vol XVIII, No. 1, PP 39-55, 1926] started a very fruitful collaboration between Syamadas Mukhopadhyay and his legendary student R.C. Bose.

They discussed in that paper the scope to extend to all hyperbolic triads the well-known Concurrency theorems of the angle bisectors and the right bisectors of the sides a triangle formed by three line elements meeting at three actual vertices.

Actually, the extension of the angle bisector theorem to all possible triads of linear elements meeting at actual, improper or ideal vertices was effected by using pure geometry in an earlier paper [17] jointly written by Professor Syamadas Mukhopadhyay and his student Gurudas Bhar. The paper entitled "Generalization of Certain Theorems in the Hyperbolic Geometry of the Triangle" was published in Bull. Cal. Math. Soc. Vol. XII, No. 1, 1920-21, PP. 14-28. Under the guidance and encouragement of Professor Mukhopadhyay, Gurudas Bhar carried out more researches in geometry. Two more papers published by G. Bhar, namely (i) "Geometrical Construction for the limiting centres of a cubic" [G. Bhar Bull. Cal. Math. So . Vol. 12, 1920-21, PP. 1-4] and (ii) "The Osculating Conic in Homogeneous Co-ordinates" [G. Bhar, Bull. Cal. Math. Soc. Vol. 12, 1920-21, PP. 85-104] bear testimony to that.

R.C.Bose published a paper entitled "The theory of Associated Figures in Hyperbolic Geometry" [Bull. Cal. Math. Soc. Vol. 19, 1928, PP. 101-116]

He went on to make many important contributions in the field of non-Euclidean Geometry and established himself as a Geometer of repute. Professor Syamadas Mukhopadhyay's contribution in nurturing R.C.Bose and encouraging him to carry forward the tradition of geometrical research in the University of Calcutta deserves special mention. Later on R.C. Bose was picked up by the pioneer statistician P.C. Mahalanobis for his sound knowledge of Pure Mathematics in general and Geometry in particular and R.C.Bose became a renowned statistician in the years to come. But we shall discuss those events later.

Now we again go back to Professor Mukhopadhyay's contributions to make Calcutta University an important centre for research in Geometry. In 1931-32, Professor S. Mukhopadhyay published two important papers entitled."Lower Segments of M curves" and "Cyclic Curves of an Ellipsoid" in the Journal of the, Indian Mathematical Society. In the first of these research papers, Professor Mukhopadhyay explaind that the name M-curve (Monotropic Curve) was due to Stackel. H. Mohrmann, who-in adopting the name, gave the following precise definition

Hyperbolic Triad : By a hyperbolic triad is meant a group of three elements (points or lines) lying upon a hyperbolic plane.

"A singularity-free (that which does not intersect itself) real branch of an analytic curve, which divides the Euclidean plane into two and only two regions, and for which the curvature at every finite point is limited and different from zero, will be called a limited monotropic curve or simply an M-curve". (Mathematische Annalen)

In his investigation, Syamadas Mukhopadhyay considered M-curves which are not necessarily analytic. He has characterized the M-curves in a different way and investigated the associated problem.

As regards the second publication viz "Cyclic curves on an Ellipsoid", Professor W. Blaschke suggested in his lecture on "Selected Problems of Differential Geometry" (1932), that the object of Dr. Mukhopadhyay's paper is to study certain properties of cyclic curves on an ellipsoid, which is known to possess six vertices.

These discussions clearly reveal, the kind of excitement and interest that was generated by the search publications of Syamadas Mukhopadhyay in the mathematical world of the twentieth century.

On one hand his personal achievements added to the glory of the newly set up department of Pure Mathematics of the University of Calcutta, while on the other hand, his guidance, encouragement and suggestions brought forth a very renowned set of research workers to work on different branches of geometry and made Calcutta University an important centre of geometrical research for a long time to come.

We have been able to procure a full list of Professor Syamadas Mukhopadhyay's research publications and the complete bibliography is given below.

Complete List of Publications of Dr. Syamadas Mukhopadhyay

1. geometrical Theory of a Plane Non-Cyclic Arc, finite as well as Infinitesimal, [JASB, (NS, IV, (1908)].
2. A General Theory of Osculating Conics, I, [Jand PASB (NS), IV, No. 4, (1908), 167-168].
3. A General Theory of Osculating Conics, II, [Jand PASB (NS), IV, No. 10, (1908), 497-509].
4. New methods in the Geometry of a Plane arc I, Cyclic and Sextactic Points, [BCMS, 1, (1909), 31-37]
5. On Rates of Variation of the Osculating Conic, [BCMS, 1, No. 2, (1909), 125-130].
6. "Parametric Co-efficients in the Differential Geometry of Curves in an N-space, I, General Conceptions", [BCMS, 1, No. 2, (1909), 187-200].
7. "Parametric Coefficients in the Differential Geometry of Curves in an N-space, 11, Extension of Serret Frenet Formulae to Curves in an N-dimensional space, [BCMS, 1, No 4, (1909), 233-234].
8. "Parametric Co-efficients in the Differential Geometry of Curves in an N-space, III Fundamefital Formulae", [BCMS, 11, (1910)].
9. "Parametric Coefficients in the Differential Geometry of Curves in an N-space, IV, Expressions of the Coordinates of a point on a curve in an N-space as power series in S, [BCMS, 111, (1911),...].
10. Intrinsic Parameters in the Differential Geometry of Curves in an N-space, [Griffiths Memorial Prize Essay, (1910), Calcutta University Publications].
11. Parametric Coefficients in the Differential Geometry of Curves, V, Principal Directions and Curvatures at a singular point of a curve in an N-space, [BCMS, V, (1913-14), 13-20].
12. A note on the Stereoscopic Representation of Four-Dimensional space, [BCMS, IV, (1912-13), 15].
13. Reply to Professor Bryan's Criticism, [BCMS, VI, (1914-15), 55-56].
14. Parametric Coefficient in the Differential Geometry of Curves in an N-space, VI; On parametric co-efficient and osculating spherics to a curve in on N-space, [ACMS, VIII, (1915)].
15. A note on current view of operations through the Fourth Dimesion, [BCMS, IX, (1917)].
16. New Methods in the Geometry of a Plane Arc IL Cyclic Points and Normals, [BCMS, X, (1919), 65-72].
17. Generalization of certain Theorems in the Hyperbolic Geometry of the Triangle, [BCMS, XII, (1920-21), 14-28].

18. Geometrical Investigations on the Correspondence between a right-angled triangle, a three right-angled quadrilateral and a rectangular pentagon in Hyperbolic Geometry, [BCMS, XIII No 4, (1922-23), 211-216].
19. Some General Theorems in the Geometry of plane curve, [Sir Asutosh Mookerjee Silver Jubilee, Vol. II, (1922), Calcutta University Publications].
20. Genesis of an Elementary Arc, [BCMS, XVII, No. 4, (1926), 153].
21. On General Theorems of Co-intimacy of Symmetries and Hyperbolic Triad, [BCMS, XVII, No. 1, (1926), 39-55]. (with R.C. Bose)
22. Triadic Equations in Hyperbolic Geometry, [BCMS, XVIII, (1927)].
23. Note on T. Hayashi's paper on the Osculating Ellipses of a plane curve, [CMP, Tomo L 1, (1927)].
24. Generalized form of Bohmer's Theorem for Elliptically Curved Non-Analytic Oval, [MZ, Band 30, (1929), 560-571].
25. Extended Minimum Number Theorems of Cyclic and Sextactic on a Plane Convex Oval, [MZ, Band 33, (1931), 648-662]
26. Circles incident on an oval of undefined curvature, [TJM, Japan, 37, (1931)]
27. Lower segments of M-curves [JIMS, XIX, (1931), 75-80].
28. Cyclic curves of an Ellipsoid, [JIMS, XY, (1932), 246-250].
29. An Exposition of the Axioms of Order of Hilbert, [IPMJ, III, (1932)].
30. Gemattic extensions of elementary chains, [TJM, Japan, 38, (1933)].

Abbreviations.:

1 BCMS - Bull. Cal. Math. Soc.
2. CMP - Circolo Mathematico Palermo
3. IPMJ - Indian Physico Mathematical Journ.
4. JASB - Journ Asiatic Soc. Bengal
5. J and PASS - Journ. And Proceedings Asiatic Soc Bengal
6 JIMS - Journ. Indian Mathematical Soc.
7. MZ - Mathematische Zeitschrift
8. TJM - Tohuku Journ. Maths.

Bibhuti Bhusan Datta (1888-1958)

Bibhuti Bhusan Datta was born on the 28th June 1888 in Kanungopada village of Chittagong in undivided Bengal. At present, Chittagong belongs to Bangladesh. His father Rashikchandra Datta (1854-1926) worked in a subordinate post in the subjudge's office. His mother was Muktakeshi Devi (1861-1958). Though his parents were poor, they were honest, religious and very helpful people. Bibhuti Bhusan was the third of the couple's eleven children. Right from his childhood, Bibhuti Bhusan showed signs of intelligence.

If we analyse the life of Bibhuti Bhusan Datta, two distinct traits are noticed in his personality. In his initial years of adulthood, he was a brilliant mathematician, a famous professor of Mathematics in the University of Calcutta, a highly intelligent mathematical investigator and a pioneer researcher in the history of Mathematics committed to reinstate the glory of ancient Hindu Mathematics. In his later years, he became a saint and religious philosopher who renunciated all worldly possessions and comforts. We are interested in highlighting his role as a pioneer mathematician, who enriched the University of Calcutta with his original research in Applied Mathematics and his pioneering research in the history of ancient Hindu Mathematics.

Bibhuti Bhusan passed his entrance examination in 1907 from Chittagong Municipal School in first division and obtained a merit scholarship. In 1909, he passed the I.Sc. examination from the Presidency College, Calcutta but was unable to get a merit scholarship. In 1912, he graduated with Honours in Mathematics from the Scottish Church College, Calcutta. In 1914, he passed M.Sc. in Mixed Mathematics from the University of Calcutta and in the year 1915, he obtained the Rashbehari Ghosh scholarship and started conducting research on Hydrodynamics. In 1916, he started assisting the then Rashbehari Ghosh Professor Dr. Ganesh Prasad. After two years in 1917 he was appointed a lecturer in the Department of Applied Mathematics, University of Calcutta. It would be pertinent in this context to point out that the then Vice-Chancellor Sir Asutosh Mookedee was the man responsible for this appointment. The great connoisseur of academic excellence had once again rightly picked up a brilliant mathematician to serve the Department of Applied Mathematics. Soon after B.B. Datta started his teaching career and was considered to be a very good teacher by the students of the department. He was equally at ease teaching Statics, Dynamics, Hydrostatics, Astronomy and even a new subject of those times like the Theory of Planets. In 1919, he obtained the prestigious Premchand Roychand studentship of the University of Calcutta and was awarded the Mouat Medal and the Elliot prize for his original contributions in the field of Applied Mathematics. In 1921, he obtained the D.Sc. degree from the University of Calcutta for his outstanding research work in the field of Hydrodynamics. We would like to mention here some of his important research contributions in the field of Applied Mathematics. He published several research papers on Fluid Mechanics in noted national and international journals. They are as follows:

1. "On a method for determining the non stationary state of heat in an ellipsoid", [AJM, 41(1919) 133-142].

2. "On the distribution of electricity in the two mutually influencing spheroidal conductor", [TMJ, (1920) 261-267].
3. "On the stability of the rectilinear vortices of compressible fluids in an incompressible fluid", [PM, 40(1920) 138-148].
4. "Notes on vortices of a compressible fluid", [PBMS, 2(1920) 1-9].
5. "On the stability of two co-axial rectilinear vortices of compressible fluids", [BCMS, 10(4)(1920) 219-220].
6. "On the periods of vibrations of straight vortex pair", [PBMS, 3(1921) 13-24].
7. "On the motion of two spheroids in an infinite liquid along their common axis of revolution", [AJM, 43(1921) 134-142].

Besides these, there are some unpublished research papers too. Some of them are really noteworthy.

They are as follows :

1. On the motion of spheroids in infinite fluids .
2. Development of the perterbative function when the
   i. eccentricities and ii. mutual inclinations of the orbits are small.
3. On the conduction of heat in an ellipsoid with three unequal axes.
4. On the non-stationary state of Heat in an Ellipsoid.
5. On the motion of two spheroids in an infinite liquid along the common axis of revolution.
6. Inequalities arising from figure of the earth.
7. On the conduction of heat in an ellipsoid of revolution.
8. Secular variations:
9. On the transformation theorem relating to spheroidal harmonics.
10. On the transformation theorem relating to spheroids.

Bibhutl Bhusan Datta was very keen to relate fundamental theories to their actual physical interpretation.

As an example, we may mention that in one such paper "On a physical interpretation of certain formulae in the Theory of Elasticity", B.B. Datta showed how certain formulae relating to the theory of elasticity of a homogeneous medium may be interpreted in a manner so as to lead to an explanation of Gravitation.

Another research paper entitled "On the Figures of Equilibrium of a Rotating Mass of Liquid for Laws of Attractions other than the Law of Inverse Square"– Part I, which he took up for investigation under. the guidance of Dr. Ganesh Prasad, was also quite interesting. The paper contains the results of his findings about the figures of equilibrium of a rotating mass of a homogeneous incompressible liquid whose particles, attract one another according to the laws of force other than the Newton's law of Gravitation.

In this article, in the first part, he considered the law of force to be given by $F = -\frac{\mu}{r^k}$, and showed that only when $k = -1$ an ellipsoidal figure can be a possible surface of equilibrium.

In the second part of the article, he considered the law of force to be given by $F = -\frac{k^3}{r^2} - \mu r$.

In the third part of the article, he proved a theorem for the law of direct distance which is analogous to a theorem of Poincare's for the law of inverse square of the distance.

It is clear from the discussion of the above two papers, that Bibhuti Bhusan Datta had a penchant for generalizing the results of famous Mathematicians and their propounded theories. His research in Applied Mathematics had a lot of scope for application to physical and real life problems. We shall discuss two such research papers of B.B. Datta which have relevance in applicability to practical problems even in the contemporary scenario In the early part of the twentieth century, he considered the problem of determining the non-stationary state of heat in an ellipsoid. While solving this problem, he generalized the equation of the elliptic surface using solid harmonics. Then using boundary conditions, he obtained an algebraic equation. He also found out a mathematical method for obtaining approximate values of the roots of that equation. He also calculated the changes in the thermal field in a direction perpendicular to the elliptic plane. In solving this problem, he obtained two transcendental equations. He completed this research paper in 1917 and it was finally published in 1919 as a research paper entitled "On a method for determining the non-stationary state of heat in an ellipsoid", [AJM, 41(1919) 133-142].

In this context, it is noteworthy, that with the discovery of antennas and other electrical devices, in the recent times, the solution of physical problems related to elliptical and spherical surfaces has become very important.

During the early part of the twentieth century, research in Mathematics in our country, was in its infancy. No research guides were available. There were no Hydrodynamical laboratories anywhere in India. So it was extremely difficult or to be more precise, almost impossible to carry out any experimental research work in Applied Mathematics and particularly in Fluid Mechanics. But in that situation, it is really amazing, how Bibhuti Bhusan Datta worked on the problem of the stability of circular vortices. He solved the problem using mathematical techniques. He however had no means of verifying it experimentally. But, we would like to draw your attention to the fact, that this problem is actually a real life problem, which is frequently encountered during power generation by turbines. B.B. Datta also worked extensively on compressible fluids.

In the backdrop of the early twentieth century mathematical world of India, Bibhuti Bhusan's research and contributions in Applied Mathematics deserve special mention.

If B.B. Datta's research contributions. in Fluid Mechanics is rich, his contributions in the field of History of Mathematics is stupendous. India, as is well known had a rich tradition in Mathematics. Many great mathematicians were born here and made fundamental work in the fields of Arithmetic, Algebra, Geometry & Trigonometry. But unfortunately, very few welldocumented records were available. In the nineteenth and earlier part of twentieth century, Hindu Mathematics used to be projected by western mathematicians as part of astrology. They proclaimed that Hindu Mathematics was a tool for making astrological predictions B.B. Datta was the first pioneer mathematician who expressed the ancient Indian Mathematics as a part of internationally acclaimed Pure Mathematics. He very successfully demonstrated that the ancient Hindus pursued research in Pure Mathematics and latter applied it to practical problems. He became famous for his original research in the History of ancient Hindu Mathematics.

It would be pertinent here to point out that in 1923, the then Principal of Varanasi Central College and eminent mathematician Dr. Ganesh Prasad was brought back to the Calcutta University for the second time as the Hardinge Professor of Higher Mathematics in the Department of Pure Mathematics. Dr. Ganesh Prasad himself was a famous historian of Mathematics. He inspired his two students Bibhuti Bhusan Datta and Avdesh Narayan Singh to take up research in the field of ancient Hindu Mathematics seriously. Bibhuti Bhusan was a great patriot. He greatly admired and respected the ancient Hindu and Jain mathematicians and philosophers. B.B. Datta was deeply hurt by the comments and attitude of many historians of mathematics, who without going deeply into the subject, boldly declared about the indebtedness of Hindu mathematicians to mathematicians of another country. There was also a tendency amongst many foreign historians of mathematics to totally ignore the discoveries made by ancient Indian mathematicians and bestow credit on a later mathematician of another country. Sometimes by wrong analogy and interpretation, they refused to accept the contributions of Hindu Mathematicians. Bibhuti Bhusan was very disturbed by such events. Dr. Ganesh Prasad's influence on him acted like a catalytic agent, and around. this time, he finally gave up his researches in Applied Mathematics and whole-heartedly devoted himself in unraveling the history of Hindu Mathematics. But the path was not easy. As is widely known many of the rich discoveries and contributions in science made by ancient Hindu scholars are embodied in the ancient Sanskrit books written by renowned sages. The tradition of the ancient Hindus was to compose everything in poetic form. Even the mathematicians followed this custom and their books consisted of a large number of Sanskrit slokas. For writing in that poetic fashion, one had to follow the rules of rhymes and metres. Though there were many technical terms involved and the ancient Hindus knew word numerals, still for expressing the mathematical discoveries in poetic pattern, alternative suitable words were found and freely used. Moreover because of the absence of printing press, the original writing of the masters were copied by the students and there could have been some errors in them. With the passage of time, it was difficult to identify the original. As Sailesh Das Gupta, a scholar on B.B. Datta has pointed out–"The greatest advantage in this respect, was the copius number of commentaries of such books which direct one to the true course. More than 100 commentaries have been written on Bhaskaracharya's Lilavati.

It will be the duty of the researcher to understand the objective of the writer. Though each word may have more than one meaning, he must catch the right content by analysing it in the proper context."

[Ref : Mathematician Bibhuti Bhusan Datta – Sailesh Das Gupta, Read on 28-06-1988 On behalf of Calcutta Mathematical Society.]

These were the difficulties involved, which stood in the way of bringing to the fore the contributions of ancient Hindu and Jaina mathematicians. Actually, a very large section of even the Indian population was unaware of the achievements of our ancient mathematicians and it has also been observed that because of wrong interpretation of the content, wrong deductions were made, catering incorrect information to the people.

B.B. Datta, however, achieved immense success in his venture. He was truly a great mathematician. So with a logical mind he attempted to decipher the writings of the ancient mathematicians. In this context, it is noteworthy that the famous historian of mathematics, Mr D.E. Smith very challengingly stated "As to the spread of the Hindu-Arabic Numerals in Europe, as to the origin of the numerals, as to the origin of the symbol zero, as to the early history of Roman numerals and as to the place value in notation—such problems have long attracted the attention of scholars, but fields have by no means been fully achieved".

To a great patriot like Bibhuti Bhusan, this must have been a challenge, which he took up and answered practically all the queries through his various articles and books. Dr. Datta while establishing his own theory or while contradicting a theory against the contribution of Hindu Mathematicians, first mastered all the facts about that particular theory. These included points both in favour of the theory as well as those against. it. Then he critically analysed, rejected some and accepted others. On this .basis of what he had accepted, he drew a conclusion.

Dr. Bibhuti Bhusan wrote nearly 60 articles. on contributions of ancient Hindu and Jaina mathematicians. Amongst these, some of the articles were published in foreign journals like American Mathematical Monthly, Bulletin of the American Mathematical Society, Quellen and Studien Zur Geschichte der Mathematik, Archeion and Scientia. Some of these articles were written to oppose the wrong accusations and wrong deductions related to the contribution of Hindu Mathematicians.

We would like to quote some relevant portions from his various articles to elucidate our point. In an article entitled "Geometry–Hindu Origin of Geometry", Dr. Datta writes "The Hindu Geometry commenced at a very early period, certainly not later than that in Egypt, probably earlier, in construction of alters for the Vedic sacrifice. In course of time it however, grew beyond its original sacrificial purpose or the limits of practical utility and began to be cultivated as a science for its own sake also. Indeed, there is no doubt, about the fact that the study of geometry as a science began first in India. Further, the early Hindu Geometry was much in advance of the contemporary Egyptian or Chinese Geometry. The Greek Geometry was yet to be born."

In this connection a remark by the noted Historian R.C. Dutta "Short History of Greek Mathematics", [JGC, (1984) 129] is very relevant. He writes "Though the Hindu achievements in Geometry were overshadowed at a later period, it would never be forgotten that the world owes its first lessons in Geometry not to Greece, but to India".

Dr. B.B. Datta in a very scientific way established these facts. Just to elaborate the point, we take up an example. Greek Geometrician Democritus (400 B.C.) referred to the Egyptian geometers by the term "Harpedonoptae" ["A history of Civilization in Ancient India"—Romesh

Chandra Dutta, Vol. 1, 1893, pp. 70.] The famous mathematician—Cantor (1845-1918) explained that the word was created by compounding two Greek words and means "rope-fastener" or "rope-stretcher". Dr. Datta reasoned that in Greece, as well as in Egypt, geometry were always referred to as "land-measurer". So the conception of the word "rope-fastener" or "rope-stretcher" is neither Greek nor Egyptian where as in Sanskrit the synonym of geometer is "sulba-bid" which when translated mean "the expert in rope-measurement". Actually the ancient Hindu treatises on geometry are called "Sulba-Sutras" or the "rules of rope measurement". On the strength of such findings B.B. Datta commented "Hence Democritas, I presume, got his term for the geometers in his Indian travels. Here is then probably a specific instance of the contact of the Hindu and Greek geometry which almost all writers believe more or less". [B.B. Datta – "Origin and History of the Hindu names for Geometry", [QS, B. 1(2) (1929).]

In the same article, B.B. Datta has commented that, "The use of the word rajjü at least in its ordinary signification of rope occurs as early as Veda". [Rg-Veda, Atharva Veda , Satapatha Brahaman]

In a well-researched study on Algebra, Dr. B.B. Datta, established with conviction that the Arabs learnt about the subject from the Hindus. In this article on "Origin of Algebra", Dr. Datta writes

"The science of Algebra derived its name from the title of a certain work by the Arab Mohammad bin Musa, Alkhowarizmi (820 A.D.) "al-gebr-w'al mugabalah", which contains an early systematic treatment of the general subject as distinct from the science of numbers. That.... This book was translated by early western scholars together with other Arabic works on Algebra. So Europe first learnt of Algebra from the Arabs. But the subject matter of Alkhowarizmi's treatise was not his original contribution. He got it from the Hindus. Indeed as in Arithmetic, so also in Algebra, the Arabs got their first lessons from the Hindus.

The Hindus were indeed far in advance of all the other nations in Analysis. Further, it should be remembered that the form and spirit of modern Algebra are essentially Hindu, not Greecian, nor Chinese....The Hindu contributions to Algebra are of fundamental character. Even some of the technical terms which are commonly used in modem algebra are of Hindu origin."

Again in the context of use of calculus in Hindu Mathematics, Prof. B.B. Datta has said that "The use of a formula involving differentials in the works of ancient Hindu Mathematicians has been established beyond doubt. That the notions of instantaneous variation and that of motion entered into the Hindu idea of differentials as found in works of Manjula, Āryabhatta II and Bhāskara II is apparent from the epithet Tatkalika (instantaneous) gati (motion) to denote these differentials."

In another context, Bibhuti Bhusan Datta wrote "The calculation of eclipses is one of the most important problems of Astronomy. In ancient days this problem was probably more important than it is now, because the exact time and duration of the eclipse could not be foretold on account of lack of the necessary mathematical equipment on the part of the astronomer. In India, Hindus observed fast and performed various other religious rites on the occasion of eclipses. Thus the calculation was of national importance. It afforded the Hindu astronomer a means of demonstrating the accuracy of his science."

Between 1925 and 1947, Dr. Datta wrote at least 55 research papers, all concerning the mathematics of the ancient Hindus and Jainas. Dr. Datta was very well conversant in Sanskrit. He had intensively studied the Vedas, the Upanishad, the Purans, the Sanskrit literature, the treatises on ancient Indian Philosophy and the ancient books on Mathematics written in Sanskrit. From these precious sources, B.B. Datta gathered thousands of factual materials and references. In 1935, Dr. Datta's classical book "The History of Hindu Mathematics" Part I and II was published. Dr. A.N. Singh of Allahabad, University was the co-author of the book. The two volumes of the book were first published from Lahore in 1935 and 1938 respectively. In Part I of this classic we have the history of Hindu numerals in decimal place value system together with other systems followed by Hindu mathematicians in expressing numerals. Notable historians of mathematics like Rosen, Reinaud, Woepcke, Strachey, Taylor and many others did believe that the so called Hindu-Arabic numeral system was the discovery of Hindus alone. But there remained some controversy in this matter. There were some historians of mathematics who did not accept this view. Dr. Bibhuti Bhusan Datta took up the challenge and collected thousands of factual materials and references and with the help of those, in this book. he has proved the authorship of the present numerals, on a sound basis. Thus from -the so called "Hindu-Arabic numerals", one has to drop the word "Arabic". The man responsible for this memorable task is none other than Dr. B.B. Datta.

Part II of the book deals with the contributions of Hindus in Algebra. It establishes the fact that Hindus had a remarkable measure of success in obtaining the general solution in rational integers of the indeterminate equation, biquadrątic equation and barga prakanti (Pellian Equation). There was a third part of the book which remained unpublished during B.B. Datta's life time. After some investigation, the manuscript was traced. This part consists of Hindu Geometry, the contributions of Hindus in Trigonometry, Calculus, Permutation and Combination, Surds, Series and Magic Square. Out of these the History of Hindu Geometry, Trigonometry and Calculus were published in Journal of History of Sciences during 1980-83.

As we have stated earlier, right from his childhood, Bibhuti Bhusan had a great attraction for asceticism. Rather than his school books, he preferred reading more books on Philosophy. A very simple man, he had no attraction for worldly possessions and his ultimate aim was to become a Sanyasi. Although he was a much respected and admired professor in the Department of Applied Mathematics, from 1928 onwards he became very irregular in attending the university. Around 1930, he actually resigned from the Department of Applied Mathematics and moved on to a famous pilgrimage centre named Pushkar in Rajasthan and decided to stay there permanently. But he could not stay there for long. His teacher Dr. Ganesh Prasad, who was then the Hardinge Professor of Pure Mathematics, pursuaded Dr. Datta to return to the University of Calcutta. However at that time, that is in 1931, Bibhuti Bhusan was appointed as a special Readership Lecturer. He was allowed to conduct only research work and was relieved of teaching duties. In 1931, Dr. B.B. Datta delivered six lectures about ancient Hindu Geometry.

In 1932, the University of Calcutta published these lectures in the form of a book. The book was titled "The Science of Sulba—A Study of Hindu Geometry".

These lectures, were thefruit of intensive research by B.B. Datta. He revealed that the Vedic priests were concerned with the practical problems involved in the construction of alters for carrying out religious rituals. In this way they developed a type of "esotoric geometry as their secret property".

Dr. Datta found out that the problems that arose at that time for constructing altars of different shapes with given areas and fixed number of bricks needed "a varied knowledge about properties of geometrical figures including their areas, idea of mensuration, knowledge. of arithmetic and even algebra were essential for due performance".

The problems that naturally arose were:

1. Division of any figure in any assigned number of parts.
2. To draw a straight line at right angles to another straight line, from an external point.
3. To construct the geometrical shapes adhering to defined areas.
4. Combination and Transformation of areas.
5. Use of the formula $x^2 + y^2 = z^2$ in connection with Pythagoras's theorem and finding out 3 suitable numbers satisfying the equation both for integers as well as rational numbers.
6. Similar figures having different areas. While carrying out related calculations the problem of finding the value of $\sqrt{2}$ became necessary. Greek mathematician also encountered similar problems. But they left it as unsolved. But this irrational number did not trouble the ancient Hindu mathematicians. In fact the Hindu mathematicians found out very good approximations to the value of $\sqrt{2}$ as well another irrational number π. Baudhayana and Apastamba's formula gave the value of $\sqrt{2} = 1.4142156$ which is correct to 5 decimal places. Aryabhata gave a very close approximate value for π which is equal to 3.1416. This was the best value determined upto that time

Unfortunately many historians of mathematics were not prepared to accept such high degree of accuracy from Hindu mathematicians. Rodet, Smith and Heath attributed it to Greek influence. B.B.Datta after intense research in this area rejected the hypothesis of the foreign historians on three accounts.

He stated that:-

1. Such accuracy was unknown to Greek mathematicians of that time.
2. The Hindu and Jaina mathematicians had been using the number ayuta long before the Greeks became aware of such a number word of high denomination.
3. Aryabhata's result was achieved using trigonometry. The Greeks did not know Trigonometry at time.

Dr. Datta did painstaking research to establish and prove before the world the supremacy of ancient Hindu mathematics. Once convinced about a fact, Bibhuti Bhusan was very bold about defending his findings. As. an example, we may site his research on "Alphabetic numeral system". In this article, published in 1929, Dr. Datta has made a very elaborate and logically rigorous discussion. He has stated that the custom of writing numerals with the help of alphabets was quite common among the Indians, the Greeks, the Jews and the Arabs. He has discussed the method followed by ancient Indians in great details. The famous Indian mathematician Aryabhat I has used 42 alphabets for his method. He has followed "Shivasutra" in this case. Panini too had made use of "Shivasutra". In this context, Dr. Datta has fearlessly pointed out the discrepancies in the related research work of J.J. Fleet. He has commented that probably Fleet was misled by the writings of Alberuni. In this connection, it may be noted that Dr. Datta was also quite critical about the writings of Shankar Balakrishna Dikshit (Indian Astrology, 1876), Sudhakar Dwivedi (Ganaktarangini), Shri Gourishankar Hirachand Ojha (Ancient Indian Alphabets—2nd ed., 1918), C.M. Whees (On the Alphabetic Notation of the Hindus : Transactions of the Literary Society of Madras, part I, 1827). In 1935, E. Jacquet translated Dr. Data's article in French and it was published in the same year in Journal Asiatique. There was a lot of follow up publications to this article, by L. Rodet (Sur la Varitable Significance de la Notation numerique inventee per Aryabhatta, Journal Asiatique, 1880, Part-II), M Cantor (Geschichte ter Mathematik, Bd 5, Leipzig, 1907) and G.R.Kaw (Notes on Indian Mathematics Arithmetical Notation–JASB, 3(1907).

In a Bengali article on "Acharya Aryabliatta and his disciples", published in 1933, Dr. Datta has discussed in details the books written by the great mathematician and has also made his own conclusions about Aryabhatta's birthplace. He has also given some new information about Aryabhatta's disciples. Dr. B.B. Datta claims that apart from Pandu Rangaswami, Latdev and Nishankuba Spanker, Prabhakar, Bhaskar and Lalla were also Aryabhata's students. The famous historian of Mathematics, Kripashankar Shukla has proved in one of his articles that Bhaskar was not a student of Aryabhata. He has rejected Dr. Datta's theory with adequate logical reasoning. Many historians of mathematics have indicated South India as the birthplace of Aryabhata. Shankar Balakrishna Dikshit has commented that almanacs following Aryabhata's Siddhanta are used in South India and specially by the Vaishnavite Sects of Karnataka and Mysore. So Dikshit thinks that Aryabhata was born in South India. Sambasiv Shastri has also supported this view. Dr. B.B. Datta with the help of beautiful logic has rejected these views and established that Aryabhata was born in a place called Kusumpur close to the modern city of Patna.

This pioneer mathematician Dr. Bibhuti Bhusan Datta will be long remembered for the unique combination of mathematical brilliance and saintly leanings in his personality. His contributions as a researcher in the history of ancient Hindu Mathematics has earned him a permanent place amongst the historians of mathematics in the world. His books and articles are indispensable source materials for any serious researcher in this area. In the annals of history of mathematics in India, Bibhuti Bhusan Datta will always be a name to be remembered with reverence and respect. It was pioneers like him who accounted for the golden age of Calcutta University during the twentieth century.

A complete list of his publications in the area of history of mathematics is given below.

Contributions of B.B. Datta in History of Mathematics

1. “Al-Biruni and the origin of Arabic Numerals”, [PBMS, 7/8(1925-26) 9-23],.
2. “A Note on Hindu–Arabic Numerals”, [AMM, 33 (1926a) 220-221].
3. “Two Aryabhat as of Al-Birrani”, [BCMS, 17 (1926b) 59-74].
4. “Hindu (Non-Jaina) values of Π”, [JASB, 22 (1926c) 25-47].
5. “Early Literary Evidence of the use of Zero in India”, [AMM, 33 (1926) 449-454, and 38 (1931) 566].
6. “On. mūla, the Hindu term for roof”, [AMM, 34 (1927a) 420-423].
7. “On the Origin and Development of the idea of percent”, [AMM, 34 (1927b) 530-531].
8. “Ārybhata, the author of Ganita”, [BCMS, 18 (1927c) 5-18].
9. “Early. History of the Arithmetic of Zero and Infinity in India”, [BCMS, 18 (1927d) 165-176]
10. “The Present Mode of Expressing Numbers”, [IHQ, 3 (1927e) 530-540].
11. “The Hindu Method of Testing Arithmetical Operations”, [JASB, (n.s.), 23 (1927f) 261-267].
12. “Hindu Contributions in Mathematics”, [BAUMA, 1 (1927) 49-72 and 12 (1929) 1-36 (reprinted)]
13. “The Science of Calculation by the Board”, [AMM, 35 (1928a) 520-529].
14. “The Hindu Solution of the General Pellian Equation”, [BCMS, 19(1928b) 87-94].
15. “On Mahavira’s Solution of Rational Triangular and Quadrilaterals”, [BCMS, 20a.(1928b) 267-294].
16. “Sabda Samkhya Pranali” (The Word Numeral System in Bengali), Bangiya Sahitya Parishad Patrika, Calcutta, for B S 1335 (1928-1929) 8-30].
17. “Vaidic O Poranic Shishumar Sabda Samkhya Pranali” (Vedic and Ancient Shishumar System of writing letter numerals in Bengali), Bangiya Sahitya Parishad Patrika, Calcutta, for B.S 1335 (1928) 8-30]
18. “The Bakhshali Mathematics”, [BCMS, 21 (1929) 1-60].
19. “The Jaina School of Mathematics”, [BCMS, 21(1929) 115-145].
20. “The Scope and Development of Hindu Ganita”, [IHQ, 5(1929) 479-512].
21. “A short review of G.R. Kaye, The Bakhshali Manuscript—A Study in Mediaeval Mathematics (Calcutta 1927)”, [BCMS, 35(1929) 579-580].
22. “Aksara Samkhya Pranali” (Alphabetical Numeral Systems in Bengali), [BSPP for B.S Calcutta, [1336(1929-30) 22-50].
23. “Origin and History of the Hindu Names for Geometry”, [QSZGDMBI, (1930) 113-119].
24. “Geometry in Jaina Cosmography”, [QSZGDMBI, (1929-31) 245-254].
25. “On the supposed indebtedness of Brahmagupta to Chin-Chang Suan-Shu”, [BCMS, 22 (1930a) 39-51].
26. “The Two Bhaskaras”, [IHQ, 6 (1930) 727-730].
27. “On the Hindu names for rectilinear geometrical figures”, [JASB(n.s.), 26 (1930) 283-290]
28. “Jyamiti Shastrer Prachin Hindu Nam o Tahar Prasar” (Old Hindu names of the science of geometry and its spread in Bengal), Bangiya Sahitya Parishad Patrika, for B.S 1337 (1930) 1-6].

29. "Nama Samkhya", (Nominal numerals in Bengali), Bangiya Sahitya Parishad Patrika, B.S.1337, 7-27 (1930-31a) .
30. "Jaina Sahitya Nama Samkhya" (Nominal numerals in Jaina Literature in Bengali), [BSPP BS. 1337 (1930-31) 28-29]
31. "Ankanam Vamato Gatih", (in Bangali) [BS (1930/31c) 70-80].
32. "Dashanka–Samkhya Pranalir Udbhavan" (Development of the System of Numerals by Ten Arithmetical Numbers in Bengali), [BSPP, 3 46th year].
33. "On the Origin of the Hindu term for 'Root' ", [AMM, 38 (1931) 371-376].
34. "The Origin of Hindu Indeterminate Analysis", [A, 13 (1931) 401-407].
35. "Narayana's Method for finding approximate value of a Surd", [BCMS, 23 (1931) 187-194].
36. "Early History of the Principle of Place Value", [Scientica, 50 (1931) 1-2]
37. "Early Literary Evidence of the use of Zero in India (second article)", [AMM, 38 (1931)].
38. "The Science of the Sulba", [CUP, (1932)].
39. "Elder Aryabhatta's Rule for the Solution of Indeterminate Equations of the First Degree", [BCMS, 24 (1932) 19-36].
40. "Testimony of Early Arab Writers on the Origin of our Numerals", [BCMS, 24 1932) 193-218].
41. "On the Relation of Mahavira to Sridhara", [ISIS 17(1932) 25-33].
42. "Introduction of Arabic and Persian Mathematics into Sanskrit Literature", [PBMS, 14(1932) 7-21].
43. "Hindu Ganiter Abanati" (Decline of Hindu mathematics in Bengali), "Panchapuspa" [B.S 1339 (1932) Month of Shravan].
44. "The Algebra of Narayana", [ISIS 19, (1933) 427-485].
45. "Prachin Bangali Jyotirbid Mallikarjan Suri", (Mallikarjan Suri, the old Bengali Astronomer in Bengali), [BSPP B.S 1340(2) (1933)]
46. "Acharya Aryabhata and His Disciples and Followers", (in Bengali), [BSPP B.S 1340 (1933/34) 129-158].
47. "Mahabharate Dashamka—Samkhya", (Numerals by Ten Arithmetical Numbers in Mahabharata in Bengali), [BSPP, B.S 1341 (1934)].
48. "Mathematics of Nemaichandra", [JA, 1(1935) 129-158].
49. "Aryabhata and the Theory of the Motion of the Earth" in Bengali, [B.S 1342(1935-36) 167-183].
50. "A Lost Jaina Treatise on Arithmetic", [JA 2(1936) 38-40]
51. "Vedic Mathematics", [CHI, III(1937) 378-401 Calcutta].
52. "Application of Intermediate Analysis to Astronomical Problems". [A 21 (1938-39) 28-34].
53. "Chronology of the History of Science in India During XVIth Century", [A, 23 78-83].
54. "Some Instruments of Ancient India and their working", [JGJRI, 4(BS 1337) 249-270].
55. "Hindu Jyotise Shak Kal", [BSPP, B.S 1344(3-4) 119-145].
56. "Birshrestha Arjuner Bayas", [BSPP, B S 1344(3-4) 186-200].

Abbreviation:-

AJM—American Jour. Of Math
TMJ—Tohoka Mathematics Journal
PAf—Philosophical Magazine
PBMS—Proceedings of the Benaras Mathematical Society
BCMS—Bulletin of the Calcutta Mathematical Society
JGC—J. Gow, Cambridge
QS—Quellen and Studien
JASB—Journal of Asiatic Society of Bengal
AMM—American Mathematical Monthly
IHQ—Indian Historical Quantity
BAUMA—Bulletin of the Allahabad University Mathematical Association
QSZGDMBI—Quellen and studies Zur Geschichte der Mathematik BI
BSPP—Bangiya Sahitya Parishad Patrika
JGJRI—Journal of the Ganganath Jha Research Institute
A—Archeion
CHI—Cultural Heritage of India
CUP—Calcutta University Publications, Calcutta

Books

1. "The Sciences of Sulba", University of Calcutta, (1932).
2. "History of Hindu Mathematics", Part I (1930), Part II (1938), Part III published serially in Indian Journal of the History of Science of the Indian National Science Academy.
3. "Prachin Hindu Jyotisi", W.B State Book. Board Ganit Charcha, serially in 1983-89.

Haridas Bagchi (1888-1968)

Haridas Bagchi was born in 1888. He had his early education in Rajshahi in the present day Bangladesh. Haridas Bagchi's father Brajagopal Bagchi was also a mathematician by training, but because of financial problems he deviated to the legal profession. Haridas from his early student days had great mathematical acumen, possessing an extremely powerful ability of abstraction. By nature Haridas Bagchi was a recluse and not very active socially. He passed his BA examination with a first class first in Mathematics Honours, in 1906. In 1908, he passed the M.A. examination from the Calcutta University in both Pure Mathematics as well as Applied Mathematics obtaining first class in both the subjects and standing first in Pure Mathematics. It was indeed a rare feat of academic excellence. He was the recipient of Bankimbihari Sen gold medal, Herschel Gold medal and the prestigious Harishchandra Prize. He was a Premchand Roychand Scholar and was awarded the Mouat medal in 1910. He was the second scholar to obtain a Ph.D. degree in Mathematics from Calcutta University. In 1911 he was awarded the degree for his thesis entitled "Curves of the third order, cubics and quartics". In the earlier part of his career, Dr. Bagchi carried out research on cubics, cycloids and hypercycloids. Some of his notable research publications in this area are listed below.

1. "Note on the Common Tangents of a Cubic and one of its Sextactic Conic", [BCMS, 40(1948) 135-139].
2. "Circles of Double Contact of a Bicircular Quartic", [BCMS, 40(1948) 207].
3. "Note on a Circular Cubic with a Real Inflexion at Infinity", [BCMS, 42(1950) 73-81] (with Biswarup Mukhedee).
4. "Note on Auto Polar Plane Cubics", [RSMUP, 21 (1952) 316-334] (with M.C.Chaki)

As already stated, Dr. Haridas Bagchi started his research career as a geometrician. But after joining the Department of Pure Mathematics, Calcutta University, he was inspired and influenced by the legendry mathematician Dr. Ganesh Prasad. Dr. Bagchi wrote a number of papers in the areas of special functions, theory of functions and infinite series.

1. "Note on Laguerre's polynomial L_n(z) and its associated equations", [JRASB, 16 (1950) 17] (with N.K.Chakraborty).
2. "Note on a Triad of Functional Equations connected with the Laguerre's Polynomial L_n(z)", [BCMS, 42(1950) 57-60].
3. "Note on a Functional Equation, connected with the Weierstrassian function γ(z)", [BCMS, 42(1950) 49-52] (with Pathik Chand Chatterjee).
4. "Theory of Functions and Infinite Series", [ASNS, 5(1951) 71] (with Chatterjee P.C.).
5. "Note on a Class of Infinite Riemannian Integrals', [BCMS, 41(1949) 103-112].
6. "On Tschebyscheff's function T_n(z) and its associated equations", [JIMS, 14(1950) 35-42] (with N.K. Chakraborty).

7. “Some further relations connected with Tschebyscheff s function $T_n(z)$” [JIMS, 14 (1950) 43-46] (with N.K.Chakraborty).
8. “Note on Laguerre’s Polynomial $L_n(z)$ and its associated equation (functional and differential)”, [BCMS, 43(1951) 17-24].

Professor Bagchi guided many students. On one hand he enriched the tradition of research in geometry in Calcutta University. On the other hand he built up a strong school of research in various branches of mathematical analysis. He served the Department of Pure Mathematics fora long time, became the Hardinge Professor and Head of the Department and finally retired in 1953. He breathed his last in May, 1968. A brilliant mathematician. and an equally great teacher and researcher, he made rich contributions and played an important role in the advancement of mathematical research in the University of Calcutta.

Abbreviation:

BCMS—Bulletin of the Calcutta Mathematical Society
RSMUP—Rendiconti del Seminario Matematico della University di Padova, tome
JRASB—J. Royal. Asiatic Soc. Bengal
ASNS—Ann Scuola, Norm Super, Pisa
JIMS—J Ind. Math. Soc. (NS)

Megh Nad Saha (1893-1956)

Meghnad Saha was born on the 6th October, 1893 in the present day Bangladesh. He was the fifth child of Jagannath Saha and Bhubaneswari Debi. His father was a shopkeeper in the small village of Seoratali about 40 km. from Dacca. The Sahas were very poor and with great.difficulty they survived with their children. M.N. Saha had to struggle very hard with acute poverty right from his childhood. He had to earn his living and earn merit scholarships throughout his student days to sustain his own studies. He even had to take up menial jobs to maintain himself. But nothing could stop this genius from achieving what he did. With the help of a village medical practitioner, Saha was able to study in school. In 1909, Saha passed the collegiate entrance examination, standing first among all the candidates of erstwhile East Bengal. He joined the Intermediate Dacca College for intermediate studies. He also started taking private lessons in German language. German language was considered to be the language of science in those days. So it is clear that from the early age of sixteen Saha was preparing himself for the role of a future scientist.

In 1911, M.N. Saha joined the Presidency College in Calcutta to study B.Sc. Honours in Mathematics. S.N. Bose was his classmate and P.C. Mahalanobis was his senior by a year. Amongst his teachers in Presidency College was the great Sir J.C. Bose and Acharya P.C. Ray. After completing his B.Sc., M.N. Saha joined the famous Department of Mixed Mathematics (which later came to be known as Applied Mathematics) in the University of Calcutta to do his M.Sc. in the subject. In 1915, Meghnad Saha passed out from the Department of Applied Mathematics. Both in the B.Sc.and M.Sc. examinations S.N. Bose secured the first rank, while M.N. Saha stood second in order of merit. For sometime, both these brilliant products of the university groped in the dark, uncertain about their future. In order to help out his poor family, M.N. Saha gave private tutions to students, cycling throughout the length and breadth of the city of Calcutta. As always he maintained himself very frugally.

The legendary Vice-Chancellor Sir Asutosh Mookedee had heard about the brilliant academic achievements of these two youngsters. So, he offered lecturerships to both Saha and Bose in the. Department of Mixed Mathematics. The famed Dr. Ganesh Prasad was then the Rashbehary Ghosh Professor and Head of this Department. Both Bose and Saha had problems with Dr. Prasad. So in 1916, Sir Asutosh appointed both S.N. Bose and M.N. Saha as lecturers in the newly set up Department of Physics at a monthly emolument of Rs. 125/-. Thus began the brilliant careers of these two young, enthusiastic men who had passionate interest in modern physics. M.N. Saha and particularly S.N. Bose had special aptitudes and capabilities for application of mathematics to problems of physics. It was decided that Saha will study and specialize in Quantum theory, Thermodynamics and Statistical Mechanics, while Bose will take care of Theories of Electromagnetism and Relativity. With no guidance in teaching or research, with no modern books or library, both pursued their professions with courage, passion and hard work. The conservative older faculties of the University were critical of Sir Asutosh Mookerjee's haste in appointing such youngsters in the newly set up Department of Physics. But the young

Bose and Saha did a remarkable job. They devised the curriculum, classes were started and soon Saha and Bose's first collaborative research work entitled "On the influence of Finite Volume of Molecules on the Equation of State"[P.M., 1918] was published.

One has to remember that M.N. Saha was a star product of the department of Applied Mathematics. Using mathematics as his tool, Saha made very rich contributions in the fields of Electromagnetic waves, Astrophysics and related areas. He is world famous for his "Thermal ionization theory", which in fact is known the world over as "Saha's thermal ionization theory". This discovery transformed spectroscopy into a precise, quantitative method of investigating the physical and chemical conditions inside the sun and the stars. Saha's work was instrumental in inspiring hectic scientific activity across the world. Following Saha's inventions, the Scientists of Cambridge in U.K. and Harvard in U.S.A. made important contributions. It may be noted that all this important work by M.N. Saha was done from Calcutta while when he was a lecturer (1916-1923) in the Physics department of the newly founded University College of Science. M.N. Saha and his classmate S.N. Bose were always very up to date in their knowledge about modern mathematical physics. In 1920, they jointly made the first English translation of the key papers on Relativity. After completing his D.Sc. in 1918 from the University of Calcutta, M.N. Saha worked for sometime in Imperial College, London and also in Berlin (1920-21). On his return from abroad, M.N. Saha did not get a suitable Astrophysical laboratory and the then Palit Professor of Physics in Calcutta University, C.V. Raman was not very helpful either. So in 1923, M.N. Saha left Calcutta for Allahabad University and served there for fifteen long years till 1938. As a professor and head of the physics department M.N. Saha built up a strong research school of Physics in Allahabad. His students. like B.D. Nag Chaudhuri, D.S. Kothari, R.C. Majumder, P.K. Kichlu and many others became front ranking famous scientists of India. Moreover. while in Allahabad, M.N. Saha's new interest was in nuclear physics. His interest in this field gradually grew with time.

In 1938, M.N. Saha finally came back to Calcutta University as the Palit Professor of Physics. With lot, of hard work, inspite of severe financial constraints M.N. Saha was successful in building Asia'a first cyclotron machine. The Institute of Nuclear Physics of Calcutta University, with Saha as the founding director, was once. again the first such institute to be acquired by any University in India. In that respect, 1947 was a pioneering event in the history of nuclear physics in India, both for M.N. Saha as well as the University of Calcutta. Saha was also responsible for.building India's first electron microscope.

M.N. Saha had made many other great contributions to the nation. He was responsible for modernising and raising the Indian Association for the Cultivation of Science to its present structure. In 1951, with M.N. Saha's initiative, the Association moved to its new premises from its earlier rented building and gradually it became one of the finest research institutions in the country. M.N. Saha was the President of the Association from 1947-1950. M.N. Saha was a founder member of the governing body of the Council of Scientific and Industrial Research right from the time of its inception in 1940. M.N. Saha was also closely associated with National Planning Commission and the Atomic Energy Commission. M.N.Saha had been elected an FRS in 1927.

As chronologically arranged, courtesy CSIR M.N.Saha was the author of 88 scientific publications (excluding popular scientific articles). Here we are giving the list of his papers related to mathematical and theoretical physics.

1. "On Maxwell's Stresses", [PM, VI(1917) 33, 256].
2. "On a New Theorem in Elasticity", [JASB, New Sr. 14(1918) 421].
3. "On the Pressure of Light (with S.Chakraborty)", [JASB, New Sr. 14(1918) 425].
4. "On the Dynamics of the Electron", [PM, VI(1918) 36, 76].
5. "On the influence of the Finite Volume of Molecules on the Equation of State (with S.N. Bose)", [PM, VI(1918) 36, 199].
6. "On the Mechanical and Electro dynamical Properties of the Electron", [PR, 13(1919) 34, PR, 13 (1919) 238].
7. "On Radiation Pressure and the Quantum Theory. A Preliminary Note", [APJ, 50 (1919) 220].
8. "Ionisation in the Solar Chromosphere", [PM, VI (40) (1920) 472].
9. "Elements in the Sun", [PM, VI(40) (1920) 809].
10. "On the Problems of Temperature Radiation of Gases (Paper C)", [PM, VI(41) (1921) 267].
11. "The Atomic Radius and the Ionisation Potential", [N, 107 (1921) 682].
12. "On a Physical Theory of Stellar Spectra", [PRSL, A99 (1921) 135].
13. "On Continuous Radiation from the Sun", [N, 112 (1923) 282].
14. "The Pressure in the Reversing Layer of Stars and Origin of Continuous Radiation from the Sun", [N, 114 (1924) 155].
15. "Ionisation in Stellar Atmosphere and Steric Factor", [MNRAS, 85 (1925) 977].
16. "On New Methods in Statistical Mechanics (with R.C.Majumder)", [PM, VII(9) (1930) 584].
17. "On Propagation of Electromagnetic Waves through the Atmosphere (with R.N. Rai)", [PNIS, (1937) 359].
18. "On the Propagation of Electromagnetic Waves through the Earth's Atmosphere (Paper I) (with R.N. Rai and K.B. Mathur)", [PNIS, 4 (1938) 319].
19. "The Propagation and the Total Reflection of Electromagnetic Waves in the Ionosphere (with K.B. Mathur)" JUP, 13 (1939) 251].

Abbreviation:

PM—Phil. Mag.
PR—Phys. Rev.
N—Nature
AMRAS—Mon. Nat. Roy Astro. Soc.
IJP—Ind. Jour..Phys
JASB—Jour. Asia Soc. Bengal
APJ—Astro. Phys. Jour.
PRSL—Proc. Roy Soc., Lond.
PNIS—Proc. Nat. Inst. Sci., Ind

S.N. Bose (1894-1974)

Satyendranath Bose was born in a well to do Bengali family on the 1st January, 1894 in the city of Calcutta. Right from his childhood, he showed signs of extreme brilliance. Just to cite a few anecdotes. There was a legendary mathematics teacher in the famous Hindu School of Calcutta. His name was Upendranath Bakshi. Satyendranath was a student of that same school. In one examination, Upendranath had set a question paper in mathematics with alternatives and had allotted the usual time for a full paper in mathematics. S.N. Bose had correctly solved all the problems including the alternatives in more than one method in an hours time. Upendranath was quick to recognize the signs of a genius in the boy. As a reward to the student, the teacher had awarded him 110 out of 100.

Satyendranath, because of illness, could not sit for the Entrance examination in 1908. As a consequence, he lost a year and appeared in 1909. But perhaps, it was the best thing that could have happened to him. Because after the completion of his school, Satyendranath entered the famous Presidency College of Calcutta and had the most stimulating company of a remarkable group of classmates, N.R. Sen and M.N. Saha being the most famous amongst them.

To give another example of S.N. Bose's remarkable scholastic ability, in the Intermediate test examination in English test, the examiner Professor H.M. Percival of Presidency College was so impressed by Bose's answer, that he added an extra ten marks with the remark "This boy is a genius".

In 1911, in the I.Sc. examination, S.N. Bose topped the list. In 1913, he stood first in B.Sc. (Mathematics Honours) examination. In 1915, SN.Bose stood first in M.Sc. (Mixed Mathematics) from the University of Calcutta. In M.Sc. examination, S.N.Bose scored 736 out of 800, a record still unmatched in the University of Calcutta.

In 1915, after completing his M.Sc. in Mixed Mathematics, S.N.Bose like his contemporary M.N. Saha was groping in the dark, not knowing what to do. In the post war recessionary climate prospects for jobs were very grim. Sir Asutosh had heard about the superlative academic achievements of S N. Bose and M.N. Saha. So initially, Sir Mookerjee appointed both these youngsters in the Department of Mixed Mathematics as lecturers. But both of them had difficult relations with the then Rashbehary Ghosh Professor and the Head of the Department Professor Ganesh Prasad. S.N. Bose was rather outspoken by nature. So after a few mopths of problematic existence, Sir Asutosh Mookerjee, in 1916 appointed both of them as teaching assistants in the newly set up Department of Physics at a monthly emolument of Rs. 125/- only. M.N. Saha and specially S.N. Bose had special aptitude and capability for application of mathematics to the problems of Physics. It was decided that S.N. Bose will study and specialize in electromagnetism and relativity while M.N. Saha will take care of quantum theory, thermodynamics and statistical mechanics. The conservative older faculties of the university were critical of Sir Asutosh Mookerjee's haste in appointing fresh pass outs to such responsible positions. They felt that Sir Asutosh should have waited for the, more renowned C.V. Raman and D.M. Bose to come and join and take up the responsibilities of the newly set up Department of Physics. But much to Sir Asutosh Mookerjee's delight, the youngsters did a remarkable job. They devised a curriculum, classes were started and the first original research paper written by S.N. Bose and M.N. Saha was published. The paper was "On the influence of Finite Volume of Molecules on the Equation of State", [Phil. Mag., Ser 6, 36 (1918) 199-203].

For some time, S.N. Bose continued teaching both in the Department of Mixed Mathematics as well as Physics. He was acclaimed as a remarkably gifted teacher by the students of both the departments. After some time, he resigned from the Department of Mixed Mathematics and devoted himself fully to the Department of Physics. He helped a great deal in the development of the newly set up department. However, after a couple of years, S.N. Bose had some differences of opinion with Sir Asutosh Mookerjee and in 1921, he left Calcutta and joined the University of Dacca as a Reader. In 1924, with a generous two year travel grant received through the enthusiastic intervention of Albert Einstein, S.N. Bose went to Europe. He had the opportunity of coming in contact with Langevin and Marie Curie in Paris and Einstein and the Berlin establishment. He returned to Dacca after the European sojourn and continued teaching there. In 1927, he became a professor in the Dacca University and continued teaching there till 1944. In 1945, he returned to Calcutta and joined the University College of Science, in Calcutta University as the Guru Prasad Singh Professor of Physics and continued there till 1955. After a two-year stint as Vice-Chancellor of Viswa Bharati University, he came back to Calcutta and continued his research work in the University College of Science as a National Professor of Physics.

'The mathematical genius and India's most reputed mathematical-physicist, Professor S.N. Bose was a product of the Department of Mixed Mathematics (later called Applied Mathematics) of Calcutta University.

S.N. Bose worked on a number of topics in various branches of Science. But his most productive years were 1920-24. We have given the complete list of his publications along with this article. He has worked and produced original paper's on Classical Mechanics, Quantum Theory, Spectroscopy, Statistics, Chemistry, Mathematical Physics, Unified Field theory etc. But his most outstanding work was "Planck's Law and the Light-Quantum Hypothesis" which was published in Z. Physik in 1924 with a note from Albert Einstein. As acknowledged by both Dirac and Einstein, the new statistics derived by Bose in this research paper laid the foundation of quantum statistics. With the discovery of this statistics known as "Bose-Einstein Statistics", Bose is considered a giant among mathematical-physicists of the world. Einstein adopted this idea and extended it to atoms. This led to the prediction of the existence of phenomena which became known as Bose-Einstein Condensate. This condensate is a dense collection of bosons (which are particles with integer spin, named after Bose by Dirac). With the recent observations of Bose-Einstein Condensation in the dilute atomic gases at temperatures in milli-kelvin and micro-kelvin ranges, S.N. Bose's contributions has brought. his name to the frontiers of contemporary theoretical Physics. Particle Statistics as derived by S.N. Bose is considered by the scientific community as one of the top ten achivements of the 20th century Indian Science.

Undoubtedly, S.N.Bose's personal contributions in the field of mathematical physics is unparalleled in India. But from the point of view of leadership qualities, if we compared him with his two other contemporaries—P.C. Mahalanobis (who was senior to S.N. Bose by one year) and M.N. Saha (who was S.N.Bose's classmate), then unfortunately, S.N. Bose cuts a sorry figure. It is a well-known fact, that inspite of very meagre financial resources, P.C. Mahalanobis was able to rope in the most talented students of Calcutta University from the faculties of Pure as well as Applied Mathematics, Economics, etc. and with their help he founded the Indian Statistical Institute in Calcutta in the early thirties. It was the first institute of its kind in Asia. Mahalanobis with his exemplary persuasive skills was also instrumental in the setting up of the Statistics Department of Calcutta University in 1941. M.N. Saha, again with very limited financial resources, set up the first institute of nuclear physics in the country under the aegis of Calcutta University. He was successful in attracting some of the finest talents of the university to the newly set up institute. In contrast, if we analyse; Professor S.N. Bose's performance, when he returned to Calcutta University in 1945, we find that he never made any attempt to set up a school of research. He was surrounded by all and sundry and never cared to discriminate between the talented and the mediocre. So inspite of being a genius in the fields of mathematics and physics, he could not form or initiate a lasting school of research, which his two other contemporaries very successfully did. In a personal capacity he won many laurels. Elected an F.R.S. in 1958, S.N. Bose has placed his alma mater, the Calcutta University in the world map of mathematics and physics.

Complete Bibliography of Professor Satyendranath Bose

The equation of state of a Real Gas

1. (with M.N. Saha) "On the influence of the finite volume of Molecules on the Equation of State", [P.M., Ser. 6, 36 (1918) 199-203].
2. "On the Equation of State", [P.M., Ser. 6, 39 (1920) 456].

Classical Mechanics :

3. "The Stress Equations of Equilibrium", [BCMS, 10 (1919) 117-121].
4. "On the Herpolhode", [BCMS, 11 (1919) 21-22].

Quantum Theory

5. "On the Deduction of Rydberg's Law from Quantum Theory of Spectral Emission", [P.M., 40 (1920) 619-627].
6. "Planck's Law. and the Light-Quantum Hypothesis",[ZP, 26 (1924) 168-171].
7. "Thermal Equilibrium in the Radiation Field in the Presence of Matter", [ZP, 27 (1924) 384-393].
8. (with K. Basu) "A note on Dirac Equations and the Zeeman Effect", [IJP, 17 (1943) 301-308].

Chemistry

9. (with S.C. Biswas) "Measurement of the Decomposition Voltage in Non-aqueous Solvents", [ZPC, 125 (1927) 442-451].
10. (with P.K. Datta) "Reaction of Sulphonazides with Pyridine : Salts and Derivatives of Pyridine", [Sci & Cult, 9 (1943) 48-49].

Spectroscopy

11. (with S K. Mukherjee). "Beryllium Spectrum in the Region λ 3367-1964", [P.M, Ser 7, (1929) 197-200].

Statistics

12. "On the Complete Moment-coefficient of the D^2 statistic", [SIJS, 2 (1936) 385-396].
13. "On the Moment-coefficient of the D^2 statistic and certain Integral and Differential Equations connected with the Multivariate Normal Population", [SIJS, 3(2) (1937) 105-124]

The Ionosphere

14. "Anomalous Dielectric Constant of Artificial Ionosphere", [SC, 3 (1937) 335-337].
15. "On the total Reflection of Electromagnetic Waves in the Ionosphere" [IJP, 12 (1938) 121-144].

Mathematical Physics

16. "Studies in Lorentz Group", [BCMS, 31 (1939) 137-147].
17. (with S.C. Kar) "The Complete Solution of the Equation

$$V^2\varnothing - \frac{\partial^2\varnothing}{c^2\partial t^2} - K^2\varnothing = 4\pi\rho(xyzt)$$ [PNISI, 7 (1941) 93-102].

18. "On an integral equation associated with the equation of Hydrogen Atom", [BCMS, 37 (1945) 51-61].

Unified Field Theory

19. "The identities of Divergence in the new Unitary Theory", [comptes rendus de I' Academie des Sciences, 236 (1953) 1333-1335].
20. "A Unified Field Theory with $\frac{\pi}{\mu} = 0$, [Le Jour de Phys. et. Le Radium (Paris), 14 (1953) 641-644]
21. "Certain Consequences of the Existence of the Tensor g", [Le Jour de Phys. et. Le Radium (Paris), 14 (1953) 645-647].
22. "The affine connection in Einstein's new Unified Field Theory", [AM, 59 (1954).171-176].
23. "Solution of a Tensor Equation occurring in the Unified Field Theory", [BSMF, 83 (1955) 81-88].

Thermoluminescence

24. "A report on the study of thermoluminescence", [TBRI, 20 (1955) 177-180].

Abbreviation :

P.M—Phil. Mag.
IJP—Ind J Phys.
SIJS—Sankhya-Ind. J Stat.
BCMS—Bulletin of the Calcutta Mathematical Society
TBRI—Trans Bose Res Inst

ZP—Z. Physik
ZPC—Z. Phys. Chem.
SC—Sci. & Cult.
PNISI—Proc. Nat. Inst. Sci. India
AM—Ann. Math. USA

Nikhil Ranjan Sen (1894-1963)

Nikhil Ranjan Sen was born on May 23, 1894. His father was Shri Kalimohon Sen and mother was Shrimati Bidhumukhi Devi. He was born in the district of Daaca, now in Bangladesh. His school education started in Daaca Collegiate School but he passed his Entrance Examination from Rajsahi Collegiate School in 1909. Later he studied in Presidency College, Calcutta, Meghnad Saha and Satyendranath Bose were his classmates right from the year 1911. In Presidency College, N.R. Sen had the privilege of being taught by such illustrious professors as Acharya J.C. Bose and Acharya P.C. Roy. Undoubtedly, the young talented students like M.N. Saha, S.N. Bose and N.R. Sen were greatly influenced by these great scientists. Both the Acharyas very successfully inculcated the spirit of enquiry into these young minds. In 1913 after obtaining a first class in B.Sc. (Mathematics Honours), N.R. Sen joined M.Sc. class in the Department of Applied Mathematics (then called Mixed Mathematics) of the Calcutta University. The classes however used to be held in Presidency College. N.R. Sen took, his M.Sc. degree in 1916, securing the first class first position.

In 1917, N.R. Sen was appointed for a teaching position in the newly set up Department of Applied Mathematics of the University of Calcutta by the illustrious mathematician Vice-Chancellor Sir Asutosh Mookerjee. Sir Asutosh, as was his style. inspired and encouraged Nikhil Ranjan Sen to take up serious research work in the field of Mathematics. In the initial years of his career, N.R. Sen took a keen interest in the theory of Newtonian Potential and also in the Mathematical theories of Elasticity and Hydrodynamic waves. He published a number of research papers in these areas and published them in well known national and international journals. In 1921, he obtained the D.Sc. degree from the University of Calcutta for his original contributions in Applied Mathematics. Almost immediately after this, the Calcutta University granted him study leave and he proceeded to Germany to pursue further research. There he worked with Professor Max Von Laue. Under Prof. Von Laue, N.R. Sen carried out research in the general theory of Relativity and on cosmological problems. During his stay in Europe, Nikhil Ranjan worked at various famous centres of Advanced Study and research in Mathematics in the continent, namely Berlin, Munich and Paris. During these visits, N.R. Sen came into contact with great scientists like Max Planck, Arnold Sommerfeld, Albert Einstein and Louis de Broglie. He utilised these opportunities and seriously took up studies in the newly developed subject of Quantum Mechanics. He also learnt the mathematical theory of Probability and the theory of Topology during his stay in Germany. A remarkable fact is that though Nikhil Ranjan Sen had been trained as an Applied Mathematician, he had great interest in various branches of Pure Mathematics too.

His research activities were also spread over a wide range of subjects and topics. He did some notable work on some problems of Spherical Harmonics. Professor Ganesh Prasad, the first Rashbehary Ghosh Professor of Applied Mathematics influenced N.R. Sen in this respect. In the early thirties Dr. Sen did considerable amount of work on wave mechanics which included

Dirac's relativistic equations. He took up problems on cosmology. He investigated the relativistic effects in steller bodies. Around 1940, after Bethe's law of energy generation was established, N.R. Sen started working on problems of steller constitution. He did pioneering work in this field in this country. From 1950 onwards till the end of his life, N.R. Sen did a lot of original research in the field of Fluid Dynamics. In India, he did pioneering research work in the field of turbulence. He built up a strong team of research workers notable among his students being U.R. Burman, N.L. Ghosh and T.C. Roy.

After his return from Europe, in 1924, Dr.N.R. Sen took over as the "Rashbehary Ghosh Professor" of Applied Mathematics in the University of Calcutta. That was the begining of a glorious era for the Department of Applied Mathematics. Prof. N.R.Sen introduced new subjects in the Post-Graduate curriculum and inspired his young colleagues and research associates to take up original and challenging problems and solve them in modern areas like Relativity, Astrophysics, Quantum Mechanics, Geophysics, Statistical, Mechanics, Fluid Dynamics, Magnetohydrodynamics, Elasticity and Ballistics. He was the fountain-head of inspiration to research workers in Calcutta University and under his dynamic leadership the Department of Applied Mathematics became a vibrant centre of research and teaching in Applied Mathematics and earned a reputation throughout the country which would be hard to match. For obvious reasons, he was called the "Father" of Applied Mathematics in India.

He was instrumental in setting up a laboratory for numerical calculations in the Department of Applied Mathematics in the third decade of twentieth century. This reflects his awareness about the necessities for good research work in the area of Applied Mathematics. He was also responsible for setting up the hydrodynamical laboratory in the Department with a flume and a wind tunnel. In spite of having access to limited resources, he tried his utmost to make the department as well equipped as possible.

In spite of his very hectic schedule which involved teaching, research and administration of the Department of Applied Mathematics, Prof. N.R. Sen served on various committees and advisory bodies of scientific and educational academies and agencies all over India.

He was the founder fellow of the National Institute of Sciences ever since its inception in 1935. Throughout his life he was deeply engaged with the Indian Association for the Cultivation of Science in Calcutta and the Calcutta Mathematical Society. He worked very hard to raise the standard of the "Bulletin" published by the Calcutta Mathematical Society.

Prof. Sen made remarkable contribution in various disciplines of Applied Mathematics. His complete list of publication amply justifies this statement. But apart from his personal contributions in scientific research, his role in modernising the Department of Applied Mathematics, inspiring scores of students to take up research in different areas of Applied Mathematics and enhancing the prestige of the department as the model centre of excellent scientific research will be written in the annals of Calcutta University in golden letters. His memory is cherished by any serious research worker of Applied Mathematics not only in Bengal but all over the country.

List of Scientific Publications

1. “On the potentials of heterogeneous incomplete ellipsoids and elliptic discs”, [BCMS, 10 (1918) 157].
2. “On the external potential of infinite elliptic cylinders”, [PM, 38 (1919) 465].
3. “On a type of vibration of a thin elastic spherical shell in a gaseous medium”, [PM, 42 (1921) 185].
4. “The equation of long waves in canals of varying section”, [PM, 48 (1924) 65].
5. “Note on the propagation of waves in elastic media”, [BCMS, 16 (1924) 9].
6. “On the boundary conditions for the gravitational field equations on surfaces of discontinuity”, [AP, 4 (1924) 73].
7. “On de Sitter’s Universe”(with M.V.Laue), [AP, 4 (1924) 74].
8. “On. the calculation of the fall of potential in the ions and electron gas in contact with glowing metals”, [AP. 4 (1924) 82].
9. “On the electric particle according to Einstein’s field theory”, [ZP, 40 (1927) 667].
10. “On Fresnel’s convection in general relativity”, [PRS, 116 (1927) 73].
11. “On the separation of H-lines in Parallel and crossed electric and magnetic fields”, [ZP, 65 (1929) 673].
12. “Equations of the electron theory and Drac’s wave mechanics (I)”, [ZP, 66 (1930) 122].
13. “On the Kepler problem for the five dimensional generalized wave equation and the influence of gravitational field on spectral lines”, [ZP, 66 (1930) 686].
14. “Motion of material particles in a homogeneous gravitational field”, [ZP, 66 (1930) 693].
15. “Equations of electron theory and Dirac’s wave mechanics (II)”, [ZP, 68 (1931) 267].
16. “On the interpretation of Dirac’s matrices”, [IPMJ, 2 (1931) 1].
17. “Radiation in expanding universe”, [IPMJ, 3 (1932) 89].
18. “On Eddington’s problem of the expansion of the universe by condensation”,[Proc. R. Soc., Vol. 140, 1933, PP. 269]
19 “On Schwarzschild’s problem of the gaseous sphere”, [ZA, 7 (1933) 188].
20. “On the equilibrium of an incompressible sphere” (with N.K. Chattedee), [MNRAS, 94 (1934) 550].
21. “On the stability of cosmological models”, [ZA, 9 (1934) 215].
22. “Minimum property of the Friedman Space”, [ZA, 9 (1935) 315].
23 “Stability of the cosmological models”, [Z. Astrophys. Vol. 10, 1935, PP. 29].
24. “Rate of disappearance of the proper motion of a Nebula according to the expansion theory”, [BCMS. 27 (1935) 101].
25. “Principle of equivalence and deduction of Lorentz transformation”, [IJP, 10 (1936) 341].
26. “Size of dense spheres”, [ZA, 14 (1937) 157].
27. “Expansion of a nebula”, [BCMS, 29 (1937) 185].
28. “Two elementary theorems on polytropes”, [BCMS, 30 (1938) 11].

29. "Pressure relations in the interior of Stellar bodies", [ZA, 18 (1939) 124].
30. "On theoretical estimates of an upper limit of Stellar diameters", [IJP, 15 (1941) 209].
31. "On some thermodynamical properties of a mixture of gas and radiation", [IJP, 15 (1941) 219].
32. "On the inversion of density gradient and convection in Stellar bodies", [PNIS, 7 (1942) 183].
33. "On Stellar models based on Bethe's law of energy generation", [PNIS, 8 (1942) 317].
34. "Contribution to the theory of Stellar models", [PNIS, 8 (1942) 339].
35. "A note on the meson wave", [BCMS, 34 (1942) 61].
36. "An approximate solar model based on Bethe's law of energy generation" (with U.R. Burman), [AJ, 100(1944) 247].
37. "Note on the Cowling model of a convective radiative star" (with U.R. Burman), [IJP, 18 (1944) 212].
38. "On the internal constitution of stars of small masses according to Bethe's law of energy generation" (with U.R. Burman), [AJ, 102 (1945) 208].
39. "Note on large scale motion in viscous stars" (with N.L. Ghosh), [BCMS, 37 (1945) 141].
40. "The problem of internal constitution of stars", [BCMS, 38 (1946) 1].
41. "On the composition of stars of small masses" (with U.R. Burman), [PNIS, 14 (1948) 271].
42. "On Heisenberg's spectrum of turbulence", [BCMS, 43 (1951) 1].
43. "On a steady gravitational field of a star-cluster free from singularities" (with T.C. Roy) [ZA, 34 (1954) 84].
44. "On the decay of energy spectrum of isotropic turbulence", [PNIS, A, 23 (1957) 530].
45. "On the question of simplicity of field laws", [PNIS A, 26 (1960) 125].
46. "Isotropic turbulence preserving similarity", [JIMS. (N.S), 24 (1961) 515].

Abbreviation:

BCMS—Bulletin of the Calcutta Mathematical Society
PM—Philosophical Magazine
AP—Annls Phys
ZP—Z. Phys
PRS—Proc. R. Soc.
IPMJ—Indian Phys. Math. J.
ZA—Z. Astrophys
MNRAS—Mon. Not. R Astro. Soc.
IJP—Indian J. Phys
PNIS—Proc. Natn. Inst. Sci, India
AJ—Astrophys. J
JIMS—J. Indian Math. Soc

Rabindranath Sen (1896-1974)

Rabindranath Sen was born on the 7th January, 1896 in Dacca, the capital of present day Bangladesh. His father Jogendra Nath Sen was an advocate of the Calcutta High Court. He was also a close associate of Sir Asutosh Mookerjee. He was elected as member of the Senate and Syndicate of Calcutta University. His mother Hemanta Kumasi Devi came from a well-to-do family and was a religious and kind-hearted person. Because of his father's sudden death at a comparitively young age, R.N. Sen had his schooling in Dacca Collegiate School and graduated from Dacca College. However, he came to Calcutta for his Post-graduate studies. He obtained his M.A. degree in 1920 from the Department of Pure Mathematics, University of Calcutta. He obtained a first class in his M.A. examination.

R.N. Sen started his research work in differential geometry*, with the study of simplexes in n-dimensions. R.N. Sen's first research paper entitled "simplexes in n-dimensions" was published in the Bulletin of Calcutta Mathematical Society in 1926. [Bull. Cal. Math. Soc., Vol. 18, PP. 33-64, 1926].

In 1928 he went to work under Sir E.T. Whitaker in the Edinburgh University of Scotland, U.K., R.N. Sen was the recipient of the "Newton Scholarship". In a short span of only two years, he completed his work and in 1930, he obtained his Ph.D. degree from the Edinburgh University for his thesis entitled "On the newer theories of Space". After returning to India, from UK., for sometime Dr. Sen worked in a local private college of Calcutta and in 1933, he joined his alma mater, the Department of Pure Mathematics in Calcutta University as a lecturer. He served this famous Department for many years. In 1954, he became the Hardinge Professor and the Head of the Department of Pure Mathematics of Calcutta University. He taught in the Post-graduate class, guided research students, wrote useful text books and did brilliant research during his tenure as the Hardinge Professor of Pure Mathematics. He retired from the Department in 1961. Two special achievements which point to his remarkable ability as an administrator needs to be specially mentioned. Ever since its inception, the Department of Pure Mathematics was under the University College of Arts. It was due to Professor Sen's intense efforts, that the Department could be placed under the control of the University College of Science. The second important action was the reorganisation of the Departmental library, keeping the requirements of research activities in mind. It would not be an overstatement to say, that Professor R.N. Sen was one of the luminous stars of the Department of Pure Mathematics of the University of Calcutta.

Now let us go back to his research activities. His research activities may broadly be classified as follows :

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* Differential geometry is a mathematical discipline that uses the techniques of differential calculus, and integral calculus as well as linear algebra for studying the geometric properties of curves and surfaces.

(1) Differential Geometry of Riemannian Spaces** and

(2) Differential Geometry of Finsler Spaces***.

After completing his Ph.D. degree, for some time Dr. R.N. Sen worked on problems related to hypersurfaces. We have provided a completed list of his research publications at the end of this article. His papers listed as (5) and (6) deal with hypersurfaces.

In 1931, in the Proceedings of the Edinburgh Mathematical Society, Dr. Sen, published a research paper entitled "On one connection between Levi-Civita parallelism and Einstein's teleparallelism****" [Proc. Edinb. Math. Soc., Ser. 2, Part 4, PP. 252-255, 1931]. Between 1931 and 1946, he published a number of research papers on parallelism including a series of papers on parallelism in Riemannian Space. His work connected with teleparallelism received wide acclaim from internationally acclaimed mathematicians like Professor T. Levi-Civita of Rome, Italy.

M.C. Chaki, the most famous student of Professor R.N. Sen has stated "Sen's investigation on the behaviour of an arbitrary parallel displacement in a metric space resulted in the discovery in 1949-50, of an algebraic system of affine connections in which Levi-Civita parallelism could be identified. This work is considered as highly significant and is referred to by I.M.H. Etherington of Edinburgh University as "Senian Geometry". The algebraic system of affine connection which Professor R.N. Sen discovered, was applied to the Finsler Spaces. The four papers related to an algebraic system generated by a single element and its application in Riemannian Geometry [Papers numbered (16), (17), (18) and (19)] published in the Bulletin of Calcutta Mathematical Society between 1950 to 1952 are noteworthy.

Special mention needs to be made of Professor Sen's following two papers

1. "On new theories of space in general relativity", [Bull. Cal. Math. Soc., Vol. 56, pp. 1-14, 1964].
2. "On new'theories of space in unified field theory", [Bull. Cal. Math. Soc., Vol. 56, pp. 147-162, 1964].

dealing with general relativity and unified field theory. These papers were highly praised by famous mathemaiicians and physicists. According to Professor M.C. Chaki, the famous student of R.N. Sen, this work has been cited in the following books :

1. "Theory of Linear Connections" by Dr. J. Strink,
2. "Ricci Calculus" by J.A. Sohontin and
3. "Volesungen iiber Dilfution Geometry" by G. Vranceanu.

** Riemannian geometry is a non-Euclidean geometry in which straight lines are geodesics and in which Euclid's parallel postulate is replaced by the postulate that within a plane every pair of lines intersect. A classical Riemannian manifold has a metric defined by a special Riemannian tensor.

*** Finsler geometry is just Riemannian geometry without the quadratic restriction. It derived its name from Finsler's thesis of 1918. Actually Finsler geometry has the Finsler manifold as the main object of study.

**** Teleparallelism means an arbitrary parallelism known as distant parallelism.

This work of Prof. R.N. Sen has been mentioned and discussed in the book entitled "On the History of Unified Field Theories" written by Hubert F.M. Goenner of Gotingen University. This work has also been cited by various researchers in India and abroad.

Ram Bilas Misra in his book entitled "Differential Geometry, its past, present and future" has extensively discussed Professor R.N. Sen's contributions in different areas of Differential Geometry.

Many students of Calcutta University obtained their Ph.D. degrees under the guidance of Professor R.N. Sen. One of his students Dr. Hrishikesh Sen worked under him and later became a faculty member of the Burdwan University. Professor Sen's most famous student was Dr. M.C. Chaki. Professor Chaki also worked on Finsler geometry and on various other branches of geometry. He was a teacher of eminence and a very versatile mathematician.

Professor R.N. Sen received many academic and professional honours in his illustrious career. To mention a few, he was elected a Fellow of the National Academy of Sciences in 1954, President of the Mathematics section of the Indian Science Congress in 1956 and President of Calcutta Mathematical Society for three successive terms in 1963-66.

A distinguished academician, a capable and innovative administrator, a brilliant teacher and a very humane human being, Professor Rabindranath Sen was a luminary in the long list of pioneer mathematicians, who have enriched the University of Calcutta with their selfless, dedicated service for the enhancement of mathematical research and education in the country.

Professor Sen breathed his last on the 19th July, 1974, leaving behind him an enormous contribution in the field of Differential geometry. The complete bibliography of his published work enclosed with this article vindicates the statement.

Complete List of Publications of Professor Rabindranath Sen

1. Simplexes in n-dimensions, [BCMS, 18, (1926), 33-64].
2. Infinitesimal analysis of an arc in n-space, [PEMS, (1928), 149-159].
3. Spherical simplexes in n-dimensions, [PEMS, Ser. 2, Part I (1930). 1-10].
4. On the new field theory, [IPMJ, No. 2, (1930), 28-31].
5. On curvatures of a hypersurface, [BCMS, 23, (1931), 1 -10].
6. On rotations in hypersurfaces, [BCMS, 23, (1931), 195-209].
7. On the connection between Levi-Civita parallelism and Einstein's telerparallelism, [PEMS, Ser. 2, Part 4, (1931), 252-255].
8. Note on tubes of electromagnetic forces, [BCMS, 35, (1933), 191-196].
9. On a type of three dimensional space compatible with Clifford's parallelism [TMJ, 42, Part 2, (1936), 226-229].
10. Parallelism in Riemannian space, [BCMS, 36, (1944), 102-107].
11. Parallelism in Riemannian space II, [BCMS, 37, (1945), 153-159].
12. Parallelism in Riemannian space III, [BCMS, 38, (1946), 161-167].
13. Parallel displacement and scalar product of vectors, [PNIS, India, 14, (1948), 45-52].

14. Parallel displacement and scalar product of vectors II, [BCMS, 41, (1949), 41-461.
15. Parallel displacement and scalar product of vectors III, [BCMS, 41, (1949), 113-120].
16. 'On an algebraic system generated by a single element and its application in Riemannian Geometry, [BCMS, 42, (1950), 1-13].
17. On an algebraic system generated by a single element and its application in Riemannian Geometry II, [BCMS, 42, (1950), 117-187].
18. On an algebraic system generated by a single element and its application in Riemannian Geometry III, [BCMS, 42, (1951), 77-94].
19. Corrections to my papers on an algebraic systems etc., [BCMS, 44, No. 2, (1952)].
20. On a type of vector space, [PNIS, India, 19, (1953), 475-486].
21. On pairs of telleparallelisms, [JIMS, 17, (1953), 21-32].
22. On pairs of telleparallelisms–II, [JIMS, 19, (1955), 61-71].
23. Note on non-simple K*-space, [PNIS, India, 22, (1956), 82-85].
24. Parallelism in Differential Geometry, [Presidential address at the 43rd Session of the Indian Science Congress, Agra, (1956)].
25. On a type of Riemannian space conformal to a flat space, [JIMS, 21, (1958), 105-114].
26. A note on symmetric affine connections, [IJM, 1, (1958), 17-19].
27. On a geometry at a point of a hypersurface of a Riemannian space, [BCMS, 50, (1958), 193-203].
28. (with H. Sen) : On a generalization of a space of constant curvature, [BCMS, Golden Jubilee Commemoration Volume, (1958),129-139].
29. On a correspondence between a system of second-order symmetric tensors and a system of affine connections, [PNIS, India, 26, A, Suppl. II, (1960), 14-20].
30. On a sequence of conformal Riemannian spaces, [BCMS, 54, (1962), 107-121].
31. On an algebraic system of conformal Riemannian spaces, (IJM 4, (1962), 71-85].
32. Associate tensor and affine connections, [JIMS, 27, (1963), 45-56].
33. On new theories of space in general relativity, [BCMS, 56, (1964), 1-14].
34. On new theories of space in unified field theory, [BCMS, 56, (1964), 147-162].
35. Conformally Euclidean spaces of class one, [IJM 6, (1964), 93-104].
36. Sir Asutosh Mookerjee–Life sketch, mathematical papers and their summaries, [BCMS, Vol. 56, (1964), 49-62].
37. On an algebraic system of Riemannian spaces, [JIMS, 29, (1965), 169-185].
38. Generalization of Clifford's parallelism, [TNS, Vol. 16, (1965), 230-242].
39. (with Bandana Gupta) : On orthogonal ennuples in a pair of Riemannian spaes, [PNI, Sc., India, 32, 210-216, 1966].
40. On a characterization of conformally flat Riemannian spaces of class one, [JAuMS, Vol. 6, (1966), 172-178].
41. On conformally flat Riemannian spaces of class one, [PAMS, 17, (1966), 880-883].
42. Postulational method in the development of Mathematics, [ES, (ISCA), 1, No. 1, (1966), 31-34].

43. Application of an algebraic system in Finsler Geometry, [TNS, 18 (1967), 191-195].
44. On curvature tensors in Finsler Geometry, [TNS, 18, (1967), 217-226].
45. (with M.C. Chaki). On curvature restrictions of a certain conformally kind of conformally flat Riemannian spaces of class one, [PNI Sc., India, 33 (1967), 100-102].
46. Some generalized formulae for curvature tensor in Finsler Geometry, [IJM, 9, (1967), 211-221].
47. Generalized Curvature tensors, [BCMS, 59, (1967), 9-17].
48. Finsler spaces of recurrent curvature, [TNS, 19, No. 3, (1968), 291-299].
49. United tensor and connection in the new theories of space, [Sir Asutosh Mookerjee Centenary Volume, IACS, Jadavpur, (1968), 35-44].
50. Basic vectors of generalized Riemannian space, [IJMM, Pt. I, sp. Issue, (1968), 95-104].
51. Correction to a theorem of mine, [PAMS, 27, No. 2, (1971), 341-342].
52. On affine connections in Riemannian, almost complex and almost hermite spaces, [TNS, 25, (1972), 390-394].
53. Cyclic structures of geometric objects involving a connection and Lie derivatives, [CM, 26, (1972), 249-261].

Abbreviations

BCMS—Bull. Cal. Math. Soc.
CM—Colloquium Maths.
ES—Everyman's Science (Indian Science Congress Assoc.)
IACS—Indian Assoc for the Cultivation of Science
IJM—Indian Journ. Maths.
IJMM—Indian Journ. Mechanics and Maths.
IPMJ—Indian Physico Mathematical Journal
JAuMS—Journ. Australian Math. Soc.
JIMS—Journ. Indian Math. Soc.
PAMC—Proceedings American Math. Soc.
PEMS—Proceedings Edinburgh Math. Soc.
PNIS—Proceedings of the National Institute Sciences.
PNISc—Proceedings of the National Institute Sciences
T (NS)—Tensor (New Series)
TMJ—Tohuku Journ. Maths.

Raj Chandra Bose (1901-1987)

Professor R.C. Bose was a great mathematician and an equally great statistician. His life is a chronicle of a great intellectual, who fulfilled his mission in both the roles to perfection. His contributions to the world of science is awesome and India in general and Calcutta in particular will always cherish and remember him with great pride.

Raj Chandra was born in Hosengabad of Punjab on June 29, 1901 in a cultured middle class Bengali family. He spent the early years of his life in Rohtak, a small town in the present day Haryana. His father Pratap Chandra Bose was an army doctor and his mother was Ushangini Devi. From the begining R.C.Bose was very intelligent and had a photogeneic memory. But right from his childhood he had a rather delicate constitution. During his Matriculation examination, he was afflicted with influenza, and could not fare very well. As a consequence, he marginally missed the merit scholarship. But without a scholarship it was not possible for him to carry out his studies in Punjab. For financial reasons, in 1917 Raj Chandra shifted to Delhi. In 1919, he stood first in the Intermediate examination. Shortly after this, he lost his father and acute financial distress followed. Earlier he had lost his mother too. Raj Chandra had to take up a job in a secondary school and give some private tutions to make both ends meet. Fighting relentlessly against acute poverty, bringing up his younger brother and two younger sisters, Raj Chandra Bose continued with his education in Delhi and in 1924 he obtained the M.A degree in Applied Mathematics from the University of Delhi. Inspired by Professor Syamadas Mukhopadhyay of the Department of Pure Mathematics of Calcutta University, R.C. Bose decided to shift to Calcutta and study Pure Mathematics in the University of Calcutta. For Raj Chandra those were days of grim financial struggle. But still undaunted by adversity, he studied in the Department of Pure Mathematics and in 1927, he came out with flying colours, standing first class first in the M.A. examination in Pure Mathematics of the University of Calcutta. This was no ordinary achievement, as Calcutta University at that time was the most important centre of mathematical teaching and research in the country and the best students from all over India, used to come to study here. In the pre-independent India of those times, facilities for research and academic activities were very limited. With great difficulty, R.C. Bose managed to get a job in the Asutosh College, an undergraduate college of Calcutta. Inspite of heavy work load in the college, Raj Chandra, under the guidance and inspiration of his former teacher and mentor Professor Syamadas Mukhopadhyay, started working in the field of geometry. His first research paper on Hyperbolic Geometry in collaboration with his mentor Syamadas Mukhopadhyay was published in 1926. Since then R.C. Bose never looked back. He applied himself with single-minded devotion and for nearly seven years till 1933, he produced many original research papers of high quality in the areas of Differential Geometry of convex curves and Hyperbolic Geometry. Incidentally, a few years earlier he had started teaching in the Department of Pure Mathematics in Calcutta University, initially as a part-time teacher, but later he was absorbed as a full time faculty.

In this context, it is relevant to note that R.C. Bose came to Calcutta University at a momentous juncture of history. Professor S.D. Mukhopadhyay, who was responsible for bringing Raj Chandra to Calcutta University was himself a scholar per excellence. Under his influence and encouragement, Raj Chandra did remarkable work in the field of Hyperbolic Geometry. Moreover, around 1936, the famous German mathematician Professor F.W. Levi, had to leave Germany because of the anti Jewish policy of the then Nazi rulers. Calcutta University was extremely fortunate in getting him as the Head of the Department of Pure Mathematics. Professor Levi introduced all the new developments that were taking place in the fields of Pure Mathematics in the syllabus of Calcutta University. So topics of Abstract Algebra like groups, rings, fields, new discoveries in projective geometry, non-Euclidean geometry, the applications of vector geometry and vector calculus were all taught in Post Graduate class, giving the students of the Department of Pure Mathematics the opportunity to study at par with their international counterparts. R.C. Bose also had a chance to freely interact with Professor Levi, and in all probability this helped him develop his thought process in the lines of modern mathematicians of the time.

Meanwhile, in the early thirties, Professor P.C.Mahalanobis, the father of statistical teaching and research in India, had started a small centre in a small room in the Presidency College in Calcutta. He was attracting meritorious and talented people from different disciplines and inspiring them to do research in various branches of statistics. P.C. Mahalanobis, with his unerring capacity for selecting the right talent, roped in R.C. Bose in 1935. Professor Mahalanobis greatly encouraged R.C. Bose and the result was his note on the application of hyperspace geometry to the theory of multiple correlation ["On. the application of hyperspace geometry to the theory of multiple correlation", Sankhya, Vol. 4, PP. 338-342, 1934].

Professor P.C. Mahalanobis, the genius scientist, had realised that geometrical representations were extremely useful for investigations in theoretical statistics. R.C. Bose with his strong background of geometry and with his remarkable research contributions in the field, was undoubtedly, the most suitable man to undertake work in that area. In 1938, the world famous statistician R.A. Fisher visited Mahalanobis's newly established Indian Statistical Institute and delivered lectures there. Bose was much inspired by these lectures. He realized that there was a great scope for applying classical multidimensional geometry in multivariate analysis. Another brilliant mathematician, S.N. Roy, a product of the Department of Applied Mathematics joined the I.S.I. around this time. R.C. Bose and S.N. Roy collaborated and did some very useful research. Their significant contribution of that time comprises studies on the distribution of D^2 statistic.

R.C. Bose was a pioneer in using finite geometries, finite fields and the combinatorial problems in the construction of designs. In 1938, his paper entitled "On the application of the properties of Galois fields to the problem of construction of hyper Graeco-Latin Squares" [Sankhyi, Vol. 3, 1938, PP. 323-339] is very significant. In the introduction, Raj Chandra Bose had written "It is hoped that the properties of Galois fields and the finite geometries connected with them, will prove useful in many problems of experimental design and the author hopes to pursue this matter in subsequent papers". Indeed until the middle of 1950, Professor Bose was mainly, preoccupied in the development of a mathematical theory of design.

Under the relentless persuation of Professor P.C. Mahalanobis, the University of Calcutta finally decided to start a separate Department of Statistics and in 1941, the newly set up Department started with Professor P.C. Mahalanobis as the Honorary Head with R.C. Bose and S.N. Roy as part-time teachers. For some time, Bose continued to teach both in the Departments of Pure Mathematics as well as in the Department of Statistics. But after a couple of years, Professor R.C. Bose, resigned from the Department of Pure Mathematics and became a full time teacher in the Department of Statistics. In 1945, after Professor P.C. Mahalanobis relinquished the Headship due to his commitments at I.S.I, Professor R.C. Bose took over the headship of the Department. In 1947 he obtained the D.Lit degree from the Calcutta University for his original work on multivariate analysis and design of experiments. In 1949, R.C. Bose emigrated to U.S.A. and took up a permanent position in the University of North Carolina.

R.C. Bose continued working in diverse areas, 'notable among them being PBIB designs, mutually orthogonal Latin squares, factorial designs, rotatable designs, multidimensional designs, coding theory, file organisation, graph theory, additive number theory, projective geometry and partial geometries. He taught and guided many students. C.R. Rao, S.S. Shrikhande, D.K. Roy Chaudhuri, K.R. Nair and S. Chowla are some of his notable famous student collaborators.

Two very remarkable results need to be specially mentioned. In three papers written jointly with S.S.Shrikhande and E.T.Parker, Professor Bose nullified Euler's Conjecture on the non-existence of mutually orthogonal Latin squares of order twice an odd number. This earned him the nickname of "Euler-spoiler".

The second remarkable achievement was the development of an efficient system of error correcting binary codes known as BCH codes jointly with D.K. Roy Chaudhuri.

R.C. Bose's research work in the fields of mathematics and statistics in general and combinatorial theory, coding theory and design of experiments in particular has made long-standing impacts in the world of science. Even in very recent times, his error correcting code techniques have found applications in telecommunication engineering. His role as a mathematical statistician has earned him a permanent place in the front rank of statisticians of the world.

Professor R.C. Bose was a great mathematician and an equally great theoretical statistician. His achievements in India and abroad, have made his alma mater, the University of Calcutta proud. Professor R.C. Bose was a unique talent and he will long be remembered for the outstanding contributions that he made as a scholar extraordinary.

Professor R.C.Bose has published a total of 145 research papers, which were published in famous national and international journals. A complete academician, a man of simple habits and tastes and an Indian to the core of his heart, Prof. Bose always remained a scholar, a teacher and a brilliant researcher.

Complete List of Publications of R.C. Bose

1. (with S. Mukhopadhyaya) General theorem of cointimacy of symmetries of a hyperbolic triad. [BCMS. 17 (1926), 39-54].
2. New methods in Euclidean geometry of four dimensions. [BCMS 17 (1926); 105-140].
3. (with S. Mukhopadhyaya) Triadic equations in hyperbolic geometry. [BCMS, 18. (1927), 99-110].
4. The theory of associated figures in hyperbolic geometry. [BCMS. 19, (1928), 101-116].
5. Theorems in the synthetic geometry of the circle on the hyperbolic plane. [TMJ, (Japan) 34 (1931), 42-50].
6. On a new derivation of the fundamental formulas of hyperbolic geometry. [TMJ, (Japan) 34 (1931), 291-294].
7. Synthetic relations between any three elements of a right-angled triangle on the hyperbolic plane. [JIMS, 19 (1931), 126-129].
8. Generalizations of Roeser's correspondence between certain types of polyhydra in non-Euclidean space. [MPJ. 3 (1932), 44-51].
9. (with W. Blaschke) Quadrilateral 4-webs of curves in a plane. [MPJ. 3 (1932), 99-101].
10. Correspondence between a tetrahedron and a special type of heptahedron in hyperbolic space. [MPJ. 3 (1932), 133-137].
11. On the number of circles of curvature perfectly enclosing or perfectly enclosed by a closed convex oval. [MZ. (Leipzig) 35 (1932), 16-24]
12. Functional equations satisfied by the fundamental functions of hyperbolic geometry, and their application to the geometry of the circle. [MPJ. 4, (1933), 37-41].
13. On the application of hyperspace geometry to the theory of multiple correlation. [S, 1(1934), 338-342].
14. A note on the convex oval. [BCMS 26 (1935), 55-60].
15. A theorem on the non-Euclidean triangle. [BCMS, 26 (1935), 69-72].
16. (with S.N. Roy) Some properties of the convex oval with reference to its perimeter centroid. [BCMS, 26 (1935), 79-86].
17. (with S.N. Roy) A note on the area centroid of a closed convex oval. [BCMS, 26 (1935), 111-118].
18. (with S.N. Roy) On the four centroids of a closed convex surface. [BCMS, 26 (1935), 119-147].
19. (with S.N. Roy) On the evaluation of the probability integral of the D^2 statistic. [SC (Calcutta) 1 (1935), 436-437].
20. On the exact distribution and moment-coefficients of the D^2 statistic. [S, 2, (1936), 143-154].
21. Theory of skew rectangular pentagons of hyperbolic space. Derivation of the set of associated pentagons. [BCMS 28 (1935),159-186].
22. A note on the distribution of the differences in mean values of samples drawn from two multivariate normally distributed populations and the definition of the D^2 statistic. [S, 2 (1936), 379-384].
23. Two theorems of the convex oval. [JIMS (New Series), 2 (1936), 13-15].

24. A theorem on equiangular convex polygons circumscribing a convex curve. [JIMS (New Series), 2 (1936), 96-98].
25. Analogue of a theorem of Blaschke. [JIMS, (New Series) 2 (1936), 105-106].
26. (with P.C. Mahalanobis and S.N. Roy) Normalization of variates and the use of rectangular coordinates in the theory of sampling distributions. [S, 3, (1936), 1-40].
27. On a criterion for the existence of a cyclic point. [TMJ, (Japan) 43, (1936), 84-88].
28. A note on the osculating circles of a plane curve. [BCMS, 29, (1935), 29-32].
29. On the distribution of means of samples drawn from a Bessel functions population. [S, 3 (1938), 262-266].
30. On the application of the properties of Galois fields to the problem of construction of hyper Graeco-Latin squares, [S, 3, (1938), 323-339].
31. (with S.N. Roy) Distribution of the Studentized D^2 statistic. [S. 4, (1938), 19-38.]
32. (with K.R. Nair) Partially balanced incomplete block designs. [S, 4, (1939), 337-373].
33. (with K. Kishen) On partially balanced Youden squares. [SC, (Calcutta) 4, (1939), 136-137.]
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35. (with S.N. Roy) The use and distribution of the Studentized D^2 statistic when the variances and covariances are based on *k* samples. [S, 4, (1940), 535-542].
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42. A note on two series of balanced incomplete block designs. [BCMS, 35 (1943), 129-130].
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Abbreviations :

ADM—Ann. Discrete Math.

AE—Ann. Eugen.

AEM—A equations Math.

AISM—Ann. Inst. Statist. Math.

AMPA—Ann. Mat. Pura. AppL

AMaS—American Math. Soc.

AMS—Ann. Math. Statist.

AS—Amer. Statist

B—Biometric

BCMS—Bull. Cal. Math. Soc.

BITS—Bull. Inst. Intern. Staist.

BM—Biometrika

CICNRS—Colloq. Intern. Centre Natl. Rech. Sci.

CJM—Cand Journ. Math.

CM—Comment. Math.

CMS—Cal. Math. Soc.

CSAB—Cal. Statist Assoc. Bull.

DM—Discrete Math.

IC—Inform. Control.

IJOAR—Intern. Journ. Opinion and Attitude Res.
ISS—Inform. Sys. Sc.
JA—Journ. Algebra
JACM—Journ. Assoc. Comput Math.
JASA—Journ. American Statist. Assoc.
JCT—Journ. Combinat. Theo.
JCISS—Journ. Combinat. Inf. Sys. Sci.
JG—Journ. Geometry
JIMS—Journ. Indi Math. Soc.
JSPI—Journ. Statist. Plan. And Inf.
JRNBS—Journ. Res. Natl. Bur. Std.
MPJ—Math. Phys. Journ.
MZ—Math. Zeitschrift
NCAESTB—North Carolina Agr. Exp. Statist. Tech. Bull.
PISC—Proceed. Ind. Sci Congress
PJM—Pacific Journ. Math.
PNAS—Proceed. National Acad. Sci.
RISI—Rev. Intern. Statist. Inst.
S—Sankhya
SC—Science and Culture
Siam JAM—Siam Journ. Appl. Math.
SSM—Stud. Sci. Math.
TE—Techtonometrics
TMJ—Tohuku Journ. Math.
UM—Utilitas. Math.

Bibhutibhusan Sen (1898-1976)

Bibhuti Bhusan Sen was born on the 1st March, 1898 in a village in the district of Chittagon in the undivided Bengal. His father Shyama Charan Sen was a government pleader and his mother was Dusmanta Kumari Sen. B.B. Sen was a bright student and showed signs of brilliance right from his school days. In the matriculation examination, then conducted by the University of Calcutta, he stood first from the district of Chittagon and obtained a government scholarship. In 1913, he came to Calcutta and joined the famous Presidency College in the intermediate class. He won scholarship throughout his academic career and passed the B.Sc. (Honours) in Mathematics with a first class first rank in 1917. Though he got himself enrolled for the M.Sc. course in Mixed Mathematics at the Calcutta University, due to some problems at home, he could not sit for the final examination in 1919. However, he got over the temporary setback through his perseverance and intelligence and completed the M.Sc. examination in 1921, once again standing first class first amongst all the students who appeared that year.

He had brief stints of teaching first in a college in present day Bangladesh and then in the Ramjash College in Agra in U.P. After spending a year in U.P, he returned to Calcutta. There are reports that, Sir Asutosh Mookedee, the then Vice-Chancellor of Calcutta University had wished to bring in Sen as a lecturer in Mathematics in the Department of Mixed Mathematics. But due to the sudden death of Sir Asutosh in Patna, B.B. Sen was deprived of this privilege. In 1924, Bibhuti Bhusan Sen joined the Bengal educational service. It was a transferable job. So B.B. Sen taught at various colleges and finally in 1953 he retired as the Principal of the Hooghly Mohsin College. After a brief stint in the Birla College of Science in Pilani, in 1956, at the request of Dr. Triguna Sen, the then Rector, B.B. Sen joined the Jadavpur University in Calcutta as a Professor and Head of the Department of Mathematics. Under his leadership started the Undergraduate and Post Graduate courses in Mathematics in Jadavpur University. Simultaneously, he gradually built up a strong research school in Continuum Mechanics.

During his student days in the post graduate department of Mixed Mathematics (Applied Mathematics) department, Bibhuti Bhusan had the great fortune of being taught the special paper on the Theory of Elasticity by Professor S.N. Bose. B.B. Sen, in the process, developed a great liking for the subject. Later, Professor B.B. Sen himself taught the subject for many years as a part-time teacher in the Department of Applied Mathematics. Professor Sen did a lot of research in various branches of elasticity. He made notable contributions in elastodynamics, thermo-elasticity, visco-elasticity, magneto-elasticity, piezo-elasticity, plasticity, couple stresses, seismology etc. He perhaps guided the largest number of Ph.D. students (about 50) amongst all the contemporary mathematicians of his time. Apart from Elasticity, he also guided some research work in the field of Fluid Mechanics. His fame as a brilliant mathematician and research guide was so great, that in 1963, the then Prime Minister of India, Sri Jawaharlal Nehru, specially intervened and persuaded UGC to give special permission, so that Professor B.B. Sen who had already crossed the age of 65, could join the Visva-Bharati University.

Professor Sen virtually built up the newly set up department of mathematics in the heritage university of Visva-Bharati.

Professor Sen had obtained D.Sc. degree in Mathematics in 1946 and an interesting point to note is that his thesis was not a typed one but fully hand-written. In 1952, Professor Sen was elected a Fellow of the National Institute of Sciences.

He was a great teacher, a brilliant mathematician, a superlative research guide and a very kind-hearted and caring human being. Professor B.B. Sen had published more than 50 original research papers in reputed national and international journals. It may be noted that Professor Sen never claimed joint-authorship of research papers published by his Ph.D. students. The complete list of his research publications are given below.

1. "Flexture of a beam having a section in the form of a rightangled triangle", [BCMS, 21 (1929) 181-186].
2. "On stresses in circular rings under the action of isolated forces on the rim", [BCMS, 22 (1930) 27-38].
3. "Stresses due to a small elliptic hole or a crack on the normal axis of a deep beam under constant bending moment", [PM, 12 (1931) 312-319].
4. "On the stresses in an elastic sphere having certain discontinuous distributions of normal pressures on the surface", [BCMS, 23 (1930) 67-76].
5. "On the uniqueness of solution of problems of elasticity connected with the bending of thin plates under normal pressures", [PM, 16(7) (1933) 975-979].
6. "On the effect of small cavities and cracks in a cylinder twisted by torsional and shearing stresses", [ZAMM, 13 (1933) 374-379]..
7. "Uber Dreshschwingungen ton Kegligen Staben". [ZTP, Nr. 10 (1933)].
8. "On concentration of stresses due to a small spherical cavity in a uniform beam bent by terminal couples, [BCMS, 25 (1933) 107-114].
9. "On bending of certain loaded plates", [IPMJ, 5 (1934) 17-20].
10. "Note on some two-dimensional problems of elasticity connected with plates having triangular boundaries", [BCMS, 26 (1934) 65-72]. .
11. "Note on the stresses in some rotating circular disks of varying thickness", [PM, Ser 7 19 (1935) 1121-1125].
12. "Note on the bending of circular disks under certain non-uniform distribution of normal thrust", [PM, Ser 7 20 (1935) 1158-1163].
13. "On torsional vibrations of cylindrical rods under variable forces", [IPMJ, 6 (1935) 41-44].
14. "Note on the application of trilinear coordinates in some problems of elasticity and hydrodynamics", [BCMS, 27 (1935) 73-78].
15. "Note on the stability of a thin plate under edge thrust, the buckling being resisted by a small force varying as the displacement", [BCMS, 27 (1935) 157-164].

16. “On the stresses in some solids of revolution due to frictional forces acting on their curved surfaces”, [IPMJ, 7 (1936) 11-15].
17. “On the radial vibration of spheres under variable radial forces”, [IPMJ, 7 (1936) 43-46].
18 “Note on the transverse vibration of freely supported rectangular plates under the action of moving loads and variable forces”, [BCMS, 28 (1936) 199-208].
19. “Note on the torsion of a curved rod”, [PM, Ser 7 24 (1937) 203-272].
20. “Die spainnunge in dunnen halbkreisformengen aund halbellipetis chen scheiben die un den sie begrenzenden durchemesser rotiere”, [ZAMM, 17 (1937) 181-183].
21. “On the transverse vibration of some rotating rods of variable cross section”, [IPMJ, 8 (1937) 49-54].
22. “On the stresses produced by couples in layer of elastic material”, [BCMS, 29 (1937) 41-48].
23. “Note on the torsion of a curved rod of circular section”, [BCMS, 29 (1937) 99-108].
24. “Direct determination of stresses from the stress-equations in some two-dimensional problems of elasticity, Part I”, [PM, Ser 7 26-(1938) 98-119].
25. “Direct determination of stresses from the stress-equations in some two-dimensional problems of elasticity, Part II, Thermal Stresses”, [PM, Ser 7 (1939) 437-444].
26. “Direct determination of stresses from the stress-equations in some two-dimensional problems of elasticity, Part III, Problems of non-isotropic material”, [PM, Ser 7 27 (1939) 596-604].
27. “Stresses due to forces and couples acting in the interior of semi-infinite elastic solid”, [BCMS, 32 (1940) 72-83].
28. “Note on the bending of thin uniformely loaded plates bounded by cardioids, lemniscates and certain other quartic curves”, [PM, Ser 7 33 (1942) 294-302].
29. “Stresses in an infinite strip due to an isolated couple acting at a point inside it”, [BCMS, 34 (1942) 45-511.
30. “Stresses due to forces and couples acting in the interior of an infinite elastic slab placed on rigid foundation”, [BCMS, 35 (1943)13-20].
31. “Note on the uniqueness of solution of problems of thin plate bent by normal pressures”, [BCMS, 35 (1943) 135-140].
32. “Boundary value problems of circular disks under body forces, Part I”, [BCMS, 36 (1944) 52-62].
33. “Boundary value problems of circular disks, Part II”, [BCMS, 36 (1944) 83-86].
34. Direct determination of stresses from the stress equations in some two-dimensional problems of elasticity, Part IV—“Problems of wedges”, [PM, Ser 7 36 (1945) 66-72].
35. “Stresses in an infinite plate due to isolated forces and couples acting near a circular hole”, [PM, Ser 7 36 (1945) 211-218].

36. “Problems of thin plates with circular holes”, [BCMS, 37 (1945) 37-42].
37. “Two dimensional boundary value problems of elasticity”, [PRSL, A 187 (1946) 87-101].
38. “Boundary value problems of a heavy circular disc in a vertical plane”, [PM, Ser 7 37 (1946) 66-72].
39. “Note on the stresses in a semi-infinite plate produced by a rigid punch on the strained boundary”, [BCMS, 38 (1946) 117-120].
40. “Direct determination of stresses in thin elastic plates having cavities of different shapes”, [BCMS, 39 (1947) 113-118].
41. “Direct determination of stresses from the stress-equations in some two-dimensional problems of elasticity, Part V. Problems of curvilinear boundaries”, [PM, Ser 7 39 (1948) 992-1000].
42. “Note on the deformation produced by some symmetrical distribution of variable loads, on the plane boundary of a semi-infinite elastic solid”, [BCMS, 41 (1949) 77-82].
43. “Stresses due to nuclei of thermo-elastic strain in a thin circular plate”, [BCMS, 42 (1950) 253-255].
44. “Note on the stresses produced by nuclei of thermo-elastic strain in a semi-infinite elastic solid”, [QAM, 8 (1951) 365-369].
45. “Note on two-dimensional indentation problems of non-isotropic semi-infinite elastic medium’ [ZAMP, 5 (1954) 83-86].
46. “Note on the solution of some problems of semi-infinite elastic solids with transverse isotropy”, [IJTP, 2 (1954) 87-90].
47. “Note on a type of distortionless transmission line with variable line parametee, [IJTP, 4 (1956) 85-87].
48. “Note on a direct method of solving problems of elastic plates with circular boundaries having prescribed displacemenf’, [ZAMP, 8 (1957) 307-309].
49. “Note on some problems of thin equilateral triangular plate”, [IJTP, 5 (1957) 77-79].
50. “Direct method of solving some two-dimensional problems of elasticity” [BCMS, Golden Jubilee Commemoration Volume, (1958) 173-178].
51. “Note on the uniqueness of solution of problems connected with thin plates bent by normal pressures”, [IJTP, 7 (1959) 41-44].
52. “Note on the bending of a thin equilateral plate under tension”, [ZAMM, Band 40, (1960) 276-277].
53. “Some problems of indentation on the straight edge of a semi-infinite non-isotropic plate”, [PNISI, 26 A (1960) 10-13].
54. “Note on the transient response of a linear visco-elastic plate in the form of an equilateral triangle”, [IJTP, 10 (1962) 77-81].
55. “Note on the direct determination of steady state thermal stresses in circular disks and spheres”, [BCMS, 56 (1964) 77-81].

56. "Note on the flow of viscous liquid through a channel of equilateral triangular section under exponential pressure gradient", [RRSTSMA, 9 (1964) 307-310].
57. "Note on the problem of a finite rod of visco-elastic Voight material", [RRSTSMA, 16 (6) (1972) 1237-1241].

Abbreviation

Z4MM—Z. Fur. Angewandte Math. Und Mech.
ZTP—Z. fur. Tech. Phys.
IPMJ—Indian phys. Math. J
PRSL—Proc. R. Soc. London
QAM—Q. appl. Math.
ZAMP—Z Fur. Angewandte Math. Phys.
IJTP—Indian J theor. Phys.
BCMS—Bulletin of the Calcutta Mathematical Society
PNISI—Proc. Natn. Inst Sci. India
RRSTSMA—Rev. Roum. Sci. Tech. Ser. Mecanique Appl.

Books :

1. Mathematics for Students of Technical Schools : Part I (with P.P. Chatterjee as coauthor)—The World Press Pvt. Ltd., Calcutta (1962).
2. Mathematics for Students of Technical Schools : Part II (with P.P. Chattedee as coauthor)—The World Press Pvt. Ltd., Calcutta (1963).
3. Mechanics : Part I (with D.K. Sinha as coauthor)—The World Press Pvt. Ltd., Calcutta (1966).
4. Mechanics : Part II (with D.K. Sinha as coauthor)—The World Press Pvt. Ltd., Calcutta (1967).
5. A Treatise on Special Functions—Allied Publishers, Calcutta (1967).
6. An Elementary treatise on Laplace Transforms—The World Press Pvt. Ltd , Calcutta (1969).
7. A Treatise on Numerical Analysis—Dasgupta & Co., College Street, Calcutta (1977).

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2. W. Nowacki (1962) Thermoelasticity (Pergamon Press, New York).
3. S.P. Timoshenko and J.N. Goodier (1951) Theory of Elasticity (McGraw Hill, New York).
4. S.P. Timoshenko and S. Woinowsky-Kreiger (1959) Theory of Plates and Shells (McGraw Hill, New York).

Subodh Kumar Chakrabarty (1909-1987)

S.K. Chakrabarty was born on July 18, 1909 at Barisal in the present day Bangladesh. Having lost his father Sitala Kanta Chakrabarty at the early age of six, he was brought up by his mother Sarala Devi. He completed his early education in Bangladesh and came to Calcutta and got himself enrolled in the famous department of Applied Mathematics of the Calcutta University to pursue Post-graduate studies. In 1932 he came out with flying colours standing first class first not only from the Department of Applied Mathematics, but also securing highest marks amongst all the candidates who had appeared that year for the M.Sc. examination in different subjects.

In 1935, he joined the Department of Applied Mathematics as a part-time teacher. In 1940, Dr. H.J. Bhabha came to the Calcutta University to deliver a course of invited lectures on cosmic rays. At that time S.K. Chakrabarty was working on some discrete problems of Quantum Mechanics. After listening to Bhabha's lectures and on interacting with him, Chakrabarty got interested in the development of "cosmic ray showers" through the "cascade process". Following the physical ideas put forth by Bhabha and Heitler and also by Carlson and Openheimer, Bhabha and Chakrabarty put forward an elegant and rigorous analysis for the accurate estimation of "shower particles and quanta" at different depths, produced by an electron and a photon, in passing through solid materials or atmosphere, making a more rigorous treatment of the problem, from the standpoints of both physical assumptions and mathematical treatments. In a series of investigations, Bhabha and Chakrabarty studied the effect of "collision loss" and derived solutions for the "cascade equations", which may be used for estimating the energy distribution of the "shower particles and photons" of all energies, including. those near and even below the "critical energy".

S.K. Chakrabarty was the recipient of the prestigious Premchand Roychand Scholarship. He was awarded the D.Sc. degree in Mathematical Physics in 1943 by the University of Calcutta. He was the recipient of the Mouat Medal and the Elliot prize for his innovative researches in Mathematical Physics.

Between 1945 to 1948, Dr. Chakrabarty worked as the Director of Colaba and Alibag Observatories in Bombay. This was also the time when he in collaboration with H.J. Bhabha. developed the famous theory of "Cascade showers in Cosmic radiation". In subsequent years, they jointly made significant contributions in the Dynamo Theory of S_Q variations, relations between geomagnetic storms and emissions of solar corpuscles, earthquake source mechanisms from the analysis of seismograms etc.

In 1948, Dr. Chakrabarty went to USA, and worked for sometime in the California Institute of Technology, Pasadena as a visiting research Fellow. There he had the opportunity of working with a group of eminent seismologists under the leadership of Prof. B. Gutenberg in collaboration with C.F. Richter. He did considerable amount of work by analyzing the records of the Walker Pass earthquakes of 15 March, 1946. S.K. Chakrabarty also started his works on the response characteristics of electromagnetic seismographs and their precise estimations through experiments carried out in collaboration with Dr. Benioff, at the Seismological Laboratory, Pasadena in 1948.

A summary of some of these works in which S.K. Chakrabarty was involved incorporated in the UNESCO publication entitled "Manual of Seismological Observatory Practice" prepared by the International Committee for the standardization of seismographs and seismograms, appointed as a consequence of a resolution of UNESCO.

On his return to India, after working with the Meteorological Department of the Government of India, for some time, he finally joined the B.E.College (the present BESU) of West Bengal in 1949 and served there as professor and head of the department of mathematics till 1963. In different academic and administrative matters. Prof. S.K. Chakrabarty took a very proactive role there.

In 1963, Prof. S.K.Chakrabarty joined his alma mater, the Department of Applied Mathematics, University of Calcutta as the Rashbehary Ghosh Professor and Head of the Department. He served there till his retirement in 1974.

During his tenure in Science College, he tried very hard to encourage research in the area of theoretical seismology and mathematical geophysics. With his vast knowledge in the subject and the experience of his collaborative work with such stalwart Geophysicists as Professors B. Gutenberg, C.F. Richter, Benioff, Fleming amongst others, made him an iconic expert in the field.

Prof. S.K. Chakrabarty was a Fellow of the Academy of Sciences, Chairman of the Cosmic Ray Research Committee of the Atomic Energy Commission, Government of India and the Founder Chairman of the "Advanced Study of Mathematics" section of the University College of Science, University of Calcutta.

Prof. S.K. Chakrabarty was an eminent scholar, a distinguished scientist and a pioneer researcher in the field of Mathematical Geophysics in India. He had published about 50 original research papers in different important National and International Journals.

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3. "Notizuber den stark effect der rotationsspektren" [VVJS, ZFP, 110 Band 11, 12 Heft (1938) 688-691].
4. "Quantization under two centres of forces–part I the hydrogen molecular ion" [PM, 7, XXVIII(1939) 423-434].
5. "Production of bwests by meson and its dependence on the meson spin" [IJP, XVI(VI) (1942) 377-392].
6. (with H.J. Bhabha) "The cascade theory with collision loss" [IAS, A, 15(1942) 462].
7. (with H.J. Bhabha) "The cascade theory with collision loss" [PIAS, A, 15(1942) 464-476].

8. "Accurate calculations on the cascade theory of electronic showers without collision loss" [PNIS, 8(1942) 331].
9. (with H.J. Bhabha) "The cascade theory with collision loss"[PRS, A, 181(1943) 267-303].
10. "The atmospheric absorption curves and their dependence on the nature of primary cosmic rays" [IJP, XVI(II) (1943) 121-129].
11. "The effect of screening on the bremsstrahlung and pair-creation process and its consequence on the cascade theory" [PNIS, IX(2) (1943) 323-335].
12. "On the convergency of the solutions of cascade equations in cosmic radiation" [BCMS, 36(1944) 9-13].
13. "Photons associated with a cascade shower, [BCMS, 36(1944) 135-140].
14. (with R.C. Majumdar) "On the spin of the meson" [PR, 65(1944) 206].
15. "Shower production by mesons in cosmic radiation" [BCMS, 37(3) (1945) 95-106].
16. "Solar streams of corpuscles and their relation to magnetic storms" [MNRAS, 106(1946) 491-499].
17. "Cascade showers under thin layers of materials" [N, 158(1946) 166].
18. "Geomagnetic time variations and their relation to ionospheric conditions" [CS, 15(1946) 246-247].
19. "Frequency of micropulsations and their variations at Alibag" [GIP, X(126) (1946) 147-152].
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21. "Scientific notes" [BIMD, 10(1947) 126].
22. (with H.J. Bhabha) "Further calculations on the cascade theory" [PR, 74(10) (1948) 1352-1363].
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24. "Responses characteristics of electromagnetic seismographs and their dependence on the instrumental constants" [BSSA, 39(3) (1949) 205-218].
25. "Sudden commencements in geomagnetic field variations" [N, 167(1951) 31].
26. (with R. Pratap) "On the dynamo theory of the geomagnetic field variations" [JGR, 59(1) (1954) 1-14].
27. "The spherical harmonic analysis of the earth's main magnetic field", [IJMG, 5(1954) 63-68].
28. (with M.R. Gupta) "Calculations of the cascade theory of showers", [PR, 101(2) (1956) 813-819].
29. "Cosmic ray works at the B.E College, Howrah", [JSIR, 17A(12) Supplement (1958) 81-82].
30. "Contribution of electron tridents in cascade showers", [BCMS, The Golden Jubilee Commemoration Volume (1958) 217-223].
31. (with D. Sarkar) "Microseisms associated with Norwesters", [BSSA, 48(1958) 181-189].
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34. (with A.N. Tandon) "Calibration of electromagnetic seismographs satisfying Galitz in conditions", [BSSA, 51(1) (1961) 111-125].
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36. (with G.C. Choudhury and S.N. Roychoudhury) "Magnification curves of electromagnetic seismographs", [BSSA, 54(5) (Part A) (1964) 1459-1471].
37. "Propagation of waves. in a multilayered elastic medium and their dependence on source mechanisms", [BSSA, 57(6) (1967) 1449-1465].
38. "On hypocentral dislocations and associated seismic waves", [PSG, (1963) 47-54].
39. "Oscillations of the earth and their use in the study of the internal constitution of the earth", [BCMS, 63 (1971) 11-17].

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1. "Geophysical analysis of the earth's crust and its economic aspects", [Presidential Addresses, Indian Science Congress, Mathematics Section, Hydrabad, 1954].
2. "Oscillations of the earth and their use in the study of the internal constitution of the earth", [Presidential Addresses, Calcutta Mathematical Society, 1971

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1. "Teaching of mathematics in secondary schools" : W.B. Board of Secondary Education (1974).
2. "Elements of discrete mathematics (with applications to computer science)" : Allied Publishers Ltd. (1976).
3. "A teacher's commentary on elements of discrete mathematics" : Allied Publishers Ltd. (1978).

Abbreviation

VVJS—Verlag Von Julius Springer, Berlin Sonderbdruck
ZFP—Zeitschrift Fur Physic
PM—Philosophical Magazine
IJP—Indian J. of Physics
IAS—Indian Acad. Sci.
PIAS—Proc. Indian Acad. Sci.
PNIS—Proc. National Institute of Science (India)
PRS—Proc. Of Royal Society
BCMS—Bull. Cal. Math. Soc.
PR—Phys. Rev.
N—Nature, London
MNRAS—Mon. Not. R. Astron. Soc.
CS—Curr.Sci.
GIP—Govt. of India Publications, Simla
BIMD—Bull Ind Met. Dept.
BSSA—Bulletin of the Seismological Soc. of America
JGR—J. Geophysical Research
IJMG—Ind. J. of Meteorology and Geophysics
JSIR—J. Scientific and Industrial Res.
PSG—Proceedings of the Symposium of Geophysics, Calcutta.

Manindra Chandra Chaki (1913-2007)

Manindra Chandra Chaki was born on the 1st July in 1913 at Bagura, a town in Bangladesh. His father was Keshab Chandra Chaki and mother was Kunjakamini Debi. He had his early education in Bangladesh. After completing his Matriculation examination he came over to Calcutta and got himself admitted to Bangabasi College, a private college in the city. In 1936, he passed M.A. in Pure Mathematics with a first class from the University of Calcutta. In 1956, he, under the guidance of Professor R.N. Sen, the famous geometrician, obtained his D.Phil degree for the thesis entitled "On some problems in Riemannian Geometry", from the University of Calcutta. One of the examiners of the thesis, Professor L.P. Eisenhart of Princeton University, U.S.A. highly praised the work..

After completing his M.Sc., M.C.Chaki Worked as a mathematics faculty in a number of under-graduate colleges in both Bangladesh and India. Finally, he joined the Pure Mathematics Department of Calcutta University as a lecturer in 1952. In 1972 he was selected the Sir Asutosh Birth Centenary Professor of Higher Mathematics (formerly Hardinge Professor) in the Calcutta University and adorned that post till his retirement in 1978.

Dr. M.C. Chaki was a prolific researcher in various branches of Geometry. He made notable contributions in the fields of Riemannian Geometry, Classical Differential Geometry, Modern Differential Geometry, Theoretical Physics, General Relativity and Cosmology and History of Mathematics. More than twenty students obtained their Ph.D degree under his guidance. His own contributions are more than 70 research papers published in various national and international journals. He wrote a number of text books starting from the Higher Secondary level to the Post-graduate level. He won many academic recognitions and served in various academic committees.

On the 21st July, 2007, this legendary mathematician breathed his last.

A list of Professor Chaki's more Important Research Papers are given below.

A. Projective Geometry

1) (with Haridas Bagchi) "Note on coillineation-group connected with a Plane Quadrangle" [PNASI, 23(111) (1954)].
2) (with Haridas Bagchi) "Note on Certain Remarkable Types of Plane Collineations" [EDASNSP, VI serie(III) Fasc. I-II 1952].
3) (with Haridas Bagchi) "Note on auto polar plane curve".

B. Riemannian Geometry

1) "Some formulas in Tensor Calculus" [BCMS, 42 (1950) 249-252].
2) "On a non-symmetric Harmonic Space" [BCMS, 44 (1952) 37-40].
3) "On a type of Tensor in a Riemannian Space" [PNISI, 22A(2) (1956)].
4) "Some formulas in a Riemannian Space" [EDASNSP, X serie(III) Fasc. I-II 1956].

5) "Some Theorems on Recurrent and Ricci-recurrent Spaces" [RSMUP, XXVI (1956)].
6) "On the line Geometry of a Curvature Tensor" [BCMS, 47 (1955)].
7) (with M.L. Ghosh) "On Quasi Conformally Flat Quasi Conformally Conservative Riemannian Manifolds" [Analele Stiint... 'Al Cuza' Lasi, (1997) 375-381].

It may be noted that in the second paper mentioned above Professor Chaki has constructed an example of a simple harmonic n space V_n, which is neither flat nor symmetric, but it is recurrent. This paper has been internationally acclaimed and has found reference in the book entitled "Harmonic Spaces" written by A.G. Walker and H.S. Ruse.

C. Differential Geometry

1) (with Bandana Gupta) "On conformally symmetric spaces" [IJM, 5(2) (1963) 113-122).

   In this particular paper, the authors have introduced a new type of Riemannian Space called conformally symmetric space. Polish and Japanese researchers have extensively worked in this Riemannian Space. Some research workers in U.S.A. have studied conformally symmetric spaces with semi-Riemannian metric or indefinite metric.

2) (with A.N. Roy Chowdhury) "On Ricci recurrent spaces of second order" [IJM, 9 (1967) 279-287].
3) (with A.K. Roy) "On certain type of Kahler spaces" [PM, Tomus 26, (1979)].
4) (with K.K. Sharma) "A particular Conformally Symmetric Space" [CM, XXXV (1976)].
5) (with D. Ghosh) "On a type of K-contact Riemannian Manifold" [JAMS, XIII(4) (1972) 447-450].
6) (with D. Ghosh) "On a type of Sasakian space" [JAMS, XIII(4) (1972) 508-510].
7) "On a conformally recurrent Kahler spaces" [Tensor N.S, (1972)].
8) (with U.C. De) "On a type of Riemannian Manifold with conservative curvature Tensor" [RBS, (1981)].
9) (with Purnima Chakraborty) "On a Type of conformally flat Hypersurface of a Euclidean Manifold" [Tensor N.S, (1999) 13].
10) (with B. Chaki) "On a Type of conformally Flat Nearly Kahler Manifold" [A.S.A.L. I.C.L, Tom XXXI, (1985)].
11) (with Swapan Kumar Kar) ."On a Type of Semi-Symmetric Metric connection on a Riemannian Manifold" [JPM, 4 (1984)].
12) (with A.K. Roy) "On conformally flat Generalized 2-recurrent spaces [PM, Tomus 22, (1975)].
13) (with Gauri Kumar) "On Semi-decomposable Genaralizedconformally2-recurrent Riemannian spaces" [M, Tom 30(53) (1988) 11-18].
14) (with Manjusha Tarafdar) "On a type of Sasakian Manifold" [SJM, 16(1) (1990) 23-28].

15) (with Manjusha Tarafdar) "On a type of Sasakian Manifold" [BCMS, ML, RSR, Tom 27(75) (1983)].
16) (with U.C. De) "Sur Un-Type di Variete Riemannienne Avec le Tenseur ds Courbure Confume Conservateur" [EASSB, Tom 95(III)].
17) (with G. Kumar) "On a Type of Semisymmetric Connection on a Riemannian Manifold" [A.S.A.L.I.C.L, 1983)].
18) (with G. Kumar) "On Semi-decomposable Generalized Projective 2-recurrent Riemannian spaces" [M, (1984)].
19) (with Swapan. Kumar Kar) "On a Type of Semi-Symmetric connection on a Riemannian Manifold"[CRBS, (1983)].
20) (with A. Konar) "On a Type of Semi-Symmetric connection on a Riemannian Manifold" [JPM, (1981)].

D. Pseudo-Symmetric Manifolds

In 1987 Professor M.C. Chaki introduced the notion of Pseudo-Symmetric Manifolds. This manifold has been called Chaki $(PS)_n$ by Toomannian and in mathematical literature it is mentioned as Chaki manifold. Some of his important publications in this area are listed below:

1) "On Pseudo-Symmetric Manifolds" [A.S.A.L.I.C.L, Tom XXIII (1987)].
2) (with U.C. De) "On Pseudo-Sym metric" [AMH, 54(3-4) (1989) 185-190].
3) (with R.K. Maity) "On totally Umbilical Hypersurfaces of a Conformally Flat Pseudo Ricci Symmetric Manifolds" [Tensor N.S., 60 (1998) 254].
4) "On Pseudo Ricci Symmetric Manifolds" [BJP, 15 (1988) 526-531].
5) (with S.K. Saha) "On Pseudo Projective Symmetric Manifolds" [BI MAS, (1989)].
6) (with S.K. Saha) "On Pseudo Projective Ricci Symmetric, Manifolds" [BJP, 1-7 (1994)].
7) "On Generalized Pseudo-Symmetric Manifolds" [PM, (1994) 305-312].
8) (with S.P. Mandal) "On Generalized Pseudo-Symmetric Manifolds" [PM, (1997) 1-8].
9) (with T. Kawaguchi) "On Almost Pseudo Ricci Symmetric Manifolds" [Tensor N.S., 88 (2007)].
10) (with P. Chakraborti) "On Conformally Flat Pseudo Ricci Symmetric Manifolds" [Tensor N.S., 52 (1993) 1-6].
11) (with S. Kolay) "On Generalized 'Pseudo Ricci Symmetric Manifolds" [PMH, 28(2) (1994) 123-129].
12) (with R.K. Maity) "On Pseudo Ricci Symmetric Manifolds" [Tensor N.S., (1998)].
13) (with B. Chaki) "On Pseudo-Symmetric Manifolds Admitting a Type of Semi-symmetric connection" [SJM, 13 (1987)].
14) (with M. Tarafdar) "On Conformally Flat Pseudo Ricci Symmetric Manifolds" [PMH, 19(3) (1988)].

E. Quasi-Einstein Manifolds and Mathematical Physics:

1) (with B. Barua) "On a New Type of Riemannian Manifold and its Application to General Relativity"[M, 4(1-2) (1991) 63-65].
2) "On a Type of Fluid Space-Time Admitting Heat Flux" [BCMS, 16(2) (2008) 191-194].
3) (with R.K. Maity) "On Quasi-Einstein Manifolds" [PM, Tomas 57 (2000) 297-306].
4) "On Generalized Quasi-Einstein Manifolds" [PM, 58 (2001) 683-691].
5) "On Super Quasi-Einstein Manifolds" [PM, Tomas 64 (2004) 481-488].
6) (with M.L. Ghosh) "On Quasi-Einstein Manifolds"[IJM (B.N.Prasad Birth Centenary Commemorative Volume), 42 (2000) 211-220].
7) (with Sarbani Ray) "Space-Times with Covariant Constant Energy-Momentum Tensor" [IJTP, 35 (1992) 1027-1032].
8) (with Sarbani Ray-Gupta) "On a Type of Space-Time of General Relativity" [Tensor N.S., 64 (2003) 227-231].
9) (with P.K. Ghosal) "On Quasi-Einstein Pseudo Ricci Symmetric Manifolds" [JPM, (2002)].
10) (with P.K. Ghosal) "Some Global Properties of Quasi-Einstein Manifolds" [PM, (2003) 1-7].
11) (with B. Barua and R. Moron) "Symmetries of Synge Metric in the Relativistic Optice" [BCMS, 93 (2000) 219-224].
12) (with B. Barua) "Conformal Symmetries of Synge Metric in a Generalized Lagrange Space" [BCMS, 94(4) (2004) 325-328].

F. Statistical Manifolds:

1) "On Statistical Manifolds" [Tensor N.S., (1999) 14-17].
2) (with B. Chaki) "Some Recent Results of Generalized Statistical Manifolds" [Presented at the Fifth International Triennial Calcutta Symposium on "Probability and Statistics", Department of Statistics, Calcutta University, December (2003) 28-31].

Complete list of publications of Professor M. C. Chaki

1. Some formulas in Tensor calculus, [BCMS, 42, (1950), 249-252].
2. On a non-symmetric harmonic space, [BCMS, 44, (1952), 37-40].
3. (with H. Bagchi) : Note on certain remarkable types of plane collineations, [ASNS, Pisa (3), 6, (1952), 85-97].
4. (with H. Bagchi) : Note on autopolar plane cubics, [RSMUP, 21, (1952), 316-334].
5. (with H. Bagchi) : Note on collineation–group connected with a Plane Quadrangle, [PNASI, 23(3), (1954)].
6. On the line geometry of a curvature tensor, [BCMS, 47, (1955), 217-226].
7. Some formulas in a Riemannian space, [ASNS, Pisa (3), 10, (1956), 85-90].

8. On a type of tensor in a Riemannian space, [PNISI, Pt. A, 22, (1956), 89-97].
9. (with B. Gupta) : On conformally symmetric spaces, [IJM 5(2), (1963), 113-122].
10. (with R.N. Sen) : On curvature restrictions of a certain kind of conformally-flat Riemannian space of class one, [PNISI, Pt. A, 33, (1967), 100-102].
11. (with A.N. Roy Chowdhury) : On Ricci–recurrent space of second order, [IJM 9, (1968), 279-287].
12. (with A.N. Roy Chowdhury) : On conformally recurrent spaces of second order, [JAMS, 10, (1969), 155-161].
13. (with D. Ghosh) : On a type of sasakian space, [JAMS, 13, (1972), 508-510].
14. On conformally recurrent Kähler spaces, [Commemoration volumes for Prof. Dr. Akitsugu Kawaguchi's Seventieth birthday, Vol. II, T(N.S.). 25, (1972), 179-182].
15. (with D. Ghosh) : On a type of K-contact Riemannian manifold, [JAMS, 13, (1972), 447-450].
16. (with A.N. Roy Chowdhury) : On a type of Kdhler space, [M(C), 16(39), (1974), No. 2,223-227].
17. (with A.K. Ray): On conformally flat generalized 2-recurrent spaces, [PMD, 22, (1975), No. 1-2, 95-99].
18. In memorium : Rabindra Nath Sen (1896-1974), [BCMS, 67, (1975), No. 4, 251-257].
19. (with K.K. Sharma) : A particular conformally symmetric space, [CM, 35, (1976), No. 1, 87-90].
20. (with K.K. Sharma) : Corrections to "A particular conformally symmetric space", [CM, 38(1), (1977), 169].
21. (with D. Ghosh) : On conformally 2-recurrent spaces, [MV, 1(14), (29), No. 1, (1977), 21-23].
22. (with A.K. Ray) : On certain types of Kähler spaces, [PMD, 26(3-4), (1979), 255-262].
23. (with U.C. De) : On a type of Riemannian manifold with conservative conformal curvature tensor, [ASSBI, I 95(2), (1981), 81-84].
24. (with U.C. De) : On a type of Riemannian manifold with conservative conformal curvature tensor, [CRABS, 34(7), (1981), 965-968].
25. (with A. Konar) : On a type of semisymmetric connection on a Riemannian manifold, [JPM, 1, (1981), 77-80].
26. (with S.K. Kar) : On a type of semisymmetric metric connection on a Riemannian manifold, [CRABS, 36(1), (1983), 57-60].
27. (with M. Tarafdar) : On a type of sasakian manifold, [BMSSMRSR, (NS), 27(75), No. 3, (1983), 217-220].
28. (with G. Kumar) : On a type of semisymmetric connection on a Riemannian manifold, [ASUAICISIM, 29(2), Suppl., (1983), 41-44].
29. (with G. Kumar) : On semi-decomposable generalized projective 2-recurrent Riemannian spaces, [M(C), 26(49), No. 1, (1984), 21-28].
30. (with S.K. Kar) : On a type of semisymmetric metric connection on a Riemannian manifold, [JPM, 4, (1984), 102-107].
31. (with B. Chaki) : On a type of conformally flat nearly Kähler manifold, [ASUAICISIM, 31(3), (1985), 235-238].
32. (with B. Chaki) : On pseudo symmetric manifold admitting a type of semisymmetric connection, [SJM 13(1), (1987), 1-7].
33. On pseudo symmetric manifolds, [ASUAICISIM, 33(1), (1987), 53-58].

34. (with M. Tarafdar) : On conformally flat pseudo-Ricci symmetric manifolds, [PMH 19(3), (1988), 209-215].
35. (with G. Kumar) : On semi-decomposable generalized conformally 2-Recurrent Riemannian spaces, [M(C), 30(53), No. 1, (1988), 11-18].
36. On pseudo Ricci symmetric manifolds, [BJP, 15(6), (1988), 526-531].
37 (with U.C. De) : On pseudo symmetric spaces, [AMK 54(3-4), (1989), 185-190].
38. (with S.K. Saha) : On pseudo projective symmetric manifolds, [BIMAS, 17(1), (1989), 59-65].
39. (with M. Tarafdar) : On a type of sasakian manifold, [SJM, 16(1), (1990), 23-28].
40. Syamadas Mukhopadhyay (1866-1937), [JPM, 7, (1990), 59-65].
41. (with P. Chakrabarti) : On conformally flat pseudo-Ricci symmetric manifolds, [T (NS), 52(3), 1993), 217-222].
42. (with G. Kumar) : On semi-decomposable generalized projective 2 Recurrent Riemannian spaces, [UNTR, Ser. A 30(1-2), (1993), 129-139].
43. (with S. Koley) : On generalized pseudo Ricci symmetric manifolds, [PMH 28(2, (1994), 123-129].
44. On generalized pseudosymmetric manifolds, [PMD, 45(3-4), (1994), 305-312].
45. (with S.K. Saha) : On pseudo-projective Ricci symmetric manifolds, [BJP, 21(1-2), (1994-95), 1-7].
46. (with S. Koley) : On generalized pseudo-projective Ricci symmetric manifolds, [ASUAICISIM, 41(1), (1995-96), 75-84].
47. (with S. Ray) : Space-times with covariant-constant energy-momentum tensor, [IJTP, 35(5), (1996), 1027-1032].
48 (with S.P. Mondal) : On generalized pseudosymmetric manifolds, [PMD, 51(1-2), (1997), 35-42].
49. (with M.L. Ghosh) : On quasi-conformally flat and quasi-conformally conservative Riemannian manifolds, [ASUAICISIM, (NS), 43(2), (1997), 375-381].
50. (with R.K. Maity) : On totally umbilical hypersurfaces of a conformally flat pseudo Ricci symmetric manifold, [T (NS), 60(3), (1998), 254-257].
51. (with P. Chakrabarti) : On a type of conformally flat hyper surface of a Euclidean manifold, [T (NS), 61(1), (1999), 7-13].
52. On statistical manifolds, [T (NS), 61(1), (1999), 14-17].
53. (with R.K. Maity) : On quasi Einstein manifolds, [PMD, 57(3-4), (2000), 297-306].
54. (with B. Barua) : Symmetric of the synge metric in the relativistic optics, [BCMS, 92(3), (2000), 219-224].
55. (with M.L. Ghosh) : On quasi Einstein Manifolds. B.N. Prasad birth centenary commemoration Volume 11, [IJM 42(2), (2000), 211-220].
56. On generalized quasi Einstein manifolds, [PMD, 58(4), (2001), 683-691].
57. (with P.K Ghoshal) : On quasi Einstein pseudo Ricci symmetric manifolds, [JPM, 18, (2001), 29-36].
58. (with B. Barua) : Conformal symmetries of Synge metric in a generalized Lagrange space, [BCMS, 94(4), (2002), 325-328].
59. (with P.K. Ghoshal) : Some global properties of quasi Einstein manifolds, [PMD, 63(4), (2003), 635-641].

60. (with S. Roy Guha) : On a type of space-time of general relativity, [T (NS), 64(3), (2003), 227-231].
61. On super quasi Einstein manifolds, [PMD, 64(3-4), (2004), 481-488].
62. (with T. Kawaguchi) : On almost pseudo Ricci symmetric manifolds, [T (NS), 68(1), (2007), 10-14].
63. On a type of fluid space time admitting heat flux, [RBCMS, 16(2), (2008), 191-194].

Abbreviations

AMH—Acta.Math. Hung..
A.S.A.L.I.CL—AnaleleStn. AL.I.Cuzo, din Lasi
ASNS—Ann. Scuola Norm Super
ASSB—Ann. Soc. Sc. Bruxelles
ASUAICISIM—An. Stiint. Univ. Al. Cuza Iasi Sect I a Mat
BCMS—Bull. Cal. Math. Soc.
BIMAS—Bull. Inst. Math. Acad. Sinica
BJP—Bulg. Journ.Phys.
BMSSMRSR—Bull. Moth. Soc. Sci. Math. R. S. Roumanie
CM—Colloquium Mathematicum
CRABS—Compte Rend. Acad. Bulgari des Sc.
EASSB—Extrait des Annales de la SocieteScientifique de Buxelle
EDASNSP—Estuatto degli Anaali Senola Normale Superiore di Pisa
OM—Ind. Jour. Math.
IJTP—Indian Journ. Theo. Physics
JAuMS—Journ. Aust. Moth. Soc.
JPM—Jour. Pure Math.
M—Mathematika
Ma—Mahavisva
M(C)—Mathematics (Cluj)
ML—Math.de La
MV—Mat. Vesnik
PMD—Publ. Mathemat. Debrecen
PMH—Periodica Mathematics Hungarica
PNASI—Proc. Nat. Acad. Sci. India
PNIS, India—Proceedings National Institute Sci., India
RBS—Rend.Bulgari des Sc.
RSMUP—Rendi. Sem. Math. Univ. di Padova
RSR—R.S. de Roumenie
SJM—Soochow Journ. Math.
T—Tensor
T (NS)—Tensor (New Series)
UNTR—Univ. Nac. Tucman Rev.

Anadi Sankar Gupta (1932-2012)

Anadi Sankar Gupta was born on the 1st November, 1932 in Barisal, now in Bangladesh. He had an illustrious academic career and obtained a First Class in M.Sc. from the famous department of Applied Mathematics of the University of Calcutta in 1954. Thereafter he shifted to IIT, Kharagpur. There, under the supervision of another famous Applied Mathematician, Professor Gagan Behari Bandyopadhyay, A.S. Gupta obtained his Ph.D. degree in 1958 for his original research contributions in Fluid Mechanics. He joined the IIT, Kharagpur as a faculty member and also continued his research in various branches of Fluid Mechanics. In 1966 he was awarded the D.Sc. degree from IIT, Kharagpur for his outstanding work in the area of Fluid Mechanics. Professor A.S. Gupta made rich contributions in the field of both Newtonian as well non-Newtonian Fluid Mechanics. His publications in the fields of Magnetohydrodynamics and heat-transfer deserve special mention. Professor Gupta built up a strong school of research in Fluid Mechanics. Many students obtained their Ph.D.'s working under his supervision. L. Rai, B.S. Dandapath, S. Sengupta, P.S. Gupta, K. Rajagopal, R.N. Jana, N. Datta etc. were some of his active collaborators. Professor A.S. Gupta was one of the most renowned Professors of Mathematics in the country. He received many professional and academic awards for his superlative research contributions in the field of Fluid Mechanics. In 1972, he was awarded the prestigious S.S. Bhatnagar award. In 1980 he was elected a fellow of the Indian National Science Academy (INSA) and in 1990, he was elected a Fellow of the National Academy of Sciences (Bangalore). He published 157 research papers in reputed national and international journals. He was the author of a book named "Calculus of Variations with Applications" published by Prentice Hall of India, New Delhi.

Here we are briefly discussing Professor Gupta's research activities. He has made significant contributions in the field of magnetohydrodynamics (MHD) and the stability of flow of Newtonian and non-Newtonian fluids. His analysis of steady and transient free convection in an electrically conducting fluid [ASR, Holland, A9, (1960), 319] past a hot surface in the presence of a transverse magnetic field reveals that the field causes a reduction in the surface of heat flux. This result is in agreement with the experimental findings of A.F. Emery [JHT, Trans ASME, Ser C, (1963), 119]. Professor A.S. Gupta and P.S. Gupta have also shown that homogeneous and heterogeneous chemical reaction result in a reduction of longitudinal (Taylor) diffusion coefficient of a solute dispersed in laminar channel flow [PRS, London, A 330, (1972), 59]. Professor Gupta's corresponding analysis in the magnetohydrodynamic case [A.S. Gupta and N. Annapurna : PRS, London, A367, (1979), 281] reveals that a uniform transverse magnetic field results in a reduction of Taylor diffusion coefficient of a solute dispersed in laminar flow of a conducting fluid is a channel.

Professor A.S. Gupta [A.S. Gupta and L.N. Howard : JFM, 14, (1962), 463] derived general stability criteria for non-dissipative swirling flow of incompressible non-conducting as well as electrically conducting fluid permeated by magnetic fields. It is shown that for a swirling flow of a perfectly conducting fluid between two concentric circular cylinders in the presence of an axial current, a sufficient condition for stability with respect to axisymmetrical perturbations is that a suitable Richardson number modified to take account of the axial current is nowhere less than ¼.

Professor Gupta's large number of investigations on the flow of Newtonian and visco-elastic fluids with particular reference to their flow over a stretching surface have important applications in the polymer processing and metal processing works. Stability of the flow of a viscous fluid over a stretching surface has been analyzed by Professor A.S. Gupta [A.S. Gupta and S.N. Bhattacharya : QAM, U.S.A., XLII, (1985), 359]. They showed that the flow was stable.

The linear stability of two viscous electrically conducting fluids separated by a plane interface and permeated by a sheared magnetic field parallel to the interface was studied by S.N. Bhattacharya and A.S. Gupta [JFM, 50 (9), (2004), 125]. In this paper, it has been shown that if a magnetic field vanishes at the unperturbed interfaces, the configuration is always unstable for zero surface tension provided the magnetic diffusivities of the two fields are different.

A modest, kind and simple man, Professor A.S. Gupta will be long remembered for his remarkable research contributions, his excellent teaching abilities and for the rich school of research that he created with much care and commitment. Professor A.S. Gupta breathed his last on the 15th June, 2012.

Complete List of Publications (updated) of Dr. A.S. Gupta, Ph.D., D.Sc.,F.N.A.Sc.

1. "Advancement of a compressible heat-conducting fluid over an infinite flat plate", [ZAMM, 37(1957) 349].
2. "Shear flow of a viscoelastic fluid past a flat plate with suction", [JASS, 25(9) 1958].
3. "Effect of buoyancy forces on certain viscous flows with suction", [ASRH, 8 (1959) 309].
4. "Steady and transient free convection of an electrically conducting fluid from a vertical plate in the presence of a magnetic field", [ASRH, A 9 (1960) 319].
5. "Flow of an electrically conducting fluid past a porous flat plate in the presence of a transverse magnetic field", [ZAMP, 11(1960) 43].
6. "On the flow of an electrically conducting fluid near an accelerated plate in the presence of a magnetic field", [JPSJ, 15(1960) 1PI.
7. "Laminar stagnation flow of an-electrically conducting fluid against an infinite plate in the presence of a magnetic field", [ASRH, B 9(1961) 45].
8. "Laminar free convection flow of an electrically conducting fluid from a vertical plate with uniform surface heat flux and variable wall temperature in the presence of magnetic field", [ZAMP, 13(1962) 201].
9. "On the hydrodynamic and hydromagnetic stability of swirling flows (with L.N. Howard)", [JFM, 14(1962) 463].
10. "Rayleigh-Taylor instability of viscous electrically conducting fluid in the presence of a horizontal magnetic field", [JPSJ, 18(1963) 1073].

11. "Laminar flow in plane waves of a conducting fluid in the presence of a transverse magnetic field", [AIAA, 1(1963) 2391].
12. "On the capillary instability of a jet carrying an axial current with or without a longitudinal magnetic field". [PRSL, A 278(1964) 214].
13. "On heat transfer characteristics of two-dimensional, circular and radial (wall) jets", [AMS, 17(1965) 547].
14. (with U.S. Rao) "Hydromagnetic free convection past a vertical porous plate subjected to suction or injection", [JPSJ, 20(1965) 1936].
15. "Tidal wave propagation in a rotating conducting fluid with a magnetic field", [AIAA, 3(1965) 156].
16. "Effect of a standing sound on the magnetohydrodynamic flow past a flat plate", [ZAMP, 17(1966) 260].
17. "Hydromagnetic free convection flows from a horizontal plate",[AIAA, 4(1966) 1439].
18. (with U.S. Rao) "Hydromagnetic flow due to a rotating disc subjected to large suction", [JPSJ, 21(1966) 2390].
19. "Stability of a viscoelastic liquid film flowing down an inclined plane)", [JFM, 28(1967) 17].
20. "Circulatory flow of a conducting liquid about a porous rotating cylinder in a radial magnetic field", [AIAA, 5(1967) 380].
21. "Hall effects on thermal instability", [RRMP, TOME XII(5) (1968) 665].
22. "Stability of a viscous liquid flowing down a flexible boundary", [CJP, 46(1968) 2059].
23. "Periods of oscillation of rotating column of a perfectly conducting liquid in the presence of a uniform axial current", [PM, 2(1968) 71].
24. (with Lajpat Rai) "Hydromagnetic stability of a liquid film flowing down an inclined conducting plane", [JPSJ, 24(1968) 626].
25. "Flow of a compressible radiating fluid passing infinite plate with suction", [AIAA, 6(1968) 2209].
26. (with A.S. Chatterjee) "Dispersion of soluble matter in the hydromagnetic laminar flow between two parallel plates", [PCPS, 164(1968) 1209].
27. (with Lajpat Rai) "Note on stability of a viscoelastic liquid film flowing down an inclined plane)", [JFM, 33(1968) 87].
28. "Combined free and forced convection effects on the magneto-hydrodynamic flow through a channel", [ZAMP, 20(1969) 506].
29. (with Lajpat Rai) "Finite amplitude effects on magnetohydrodynamic thermal convection in a rotating layer of a conducting fluid", [JMAA, 29(1970) 123].
30. (with Lajpat Rai) "Stability of an elastico-viscous liquid film flowing down an inclined plane", [PCPS, 63(1967) 527].
31. "Magnetohydrodynamic Ekman layer", [AM, 13(1972) 155].
32. "Effect of conducting walls on the dispersion of soluble matter in MED channel flow", [RRP, 15(1970) 811].
33. (with P.S. Gupta) "Asymptotic suction problem in the flow of Micropolar liquids", [AM, 15(1972) 142].

34. (with S. Sen Gupta) "Thermohaline convection with finite amplitude in a rotating fluid", [ZAMP, 22 Fasc. 5 (1971) 906].
35. "Ekman layer on a porous plate", [PF, 15(1972) 930].
36. (with P.S. Gupta) "Effect of homogeneous and heterogeneous reactions on the dispersion of a solute on the laminar flow between two plates", [PRSL, A 330(1972) 59].
37. "Combined free and forced convection past a porous vertical circular cylinder", [IJP, 46(1972) 521].
38. "Decay of vortices in a viscoelastic liquid", [M, VII(4) (1972) 232].
39. "Thermo-convective waves in certain elastico-viscous liquids", [JJAP, 12(12) (1973) 1881].
40. "Diffusion with chemical reaction from a point source in a moving stream", [CJCE, 52(1974) 424].
41. "Hall effects on generalized MHD Couette flow with heat transfer", [BLRB, LX(1974) 332].
42. (with B.S. Dandpath) "On the stability of swirling flow in magnetogasdynamics", [QAM, 33(1975) 182].
43. "Radiation effect on hydromagnetic convection in a vertical channel", [IJHMT, 17(1974) 1437].
44. (with I. Pop) "Boundary layer growth in a liquid with suspended particles", [BMDSM, 19(1975) 291].
45. "Hall effects on combined free and forced convective hydromagnetic flow through a channel" [IJES, 14(1976) 285].
46. "Flow and heat transfer in the hydromagneticEKman layer on a porous plate with Hall effects" [IJHMT, 19(1976) 523].
47. "Hydromagnefic instability in a rotating channel flow", [PDIM 19(33) (1975) 147].
48. "On hydromagnetic flow and heat transfer in a rotating fluid past an infinite porous wall", [ZAMM, 55(1975) 147].
49. "Hydromagnetic flow past a porous plate with Hall effects". [AM, 22(1975) 281].
50. "Instability of a horizontal layer of a viscoelastic liquid on an oscillating plane", [JFM, 72(1975) 425].
51. "On the non-linear stability of flow of a dusty gas", [JMAA, 55(1976) 284].
52. (with B.S. Majumder) "Taylor diffusion in a falling film of a non-Newtonian liquid", [IJHMT, 20(1977) 341].
53. (with B.S. Dandpath) "Stability of magnetogasdynamics shear flow", [AM, 28(1977) 77].
54. (with I. Pop) "Effects of curvature on unsteady free convection past a circular cylinder", [PF, 20(1) (1977) 162].
55. (with P.S. Gupta) "Squeezing flow between parallel plates", [W, 45(1977) 177].
56. (with N. Datta and R.N. Jana) "Compressible flow past an oscillating porous plate", [JJAP, 16(9) (1977) 1659].
57. "Effect of suspended particles on the Ekman boundary layer", [AUBM, XXVI(1977) 45].
58. "On the dispersion of a dye with a harmonically varying concentration in the hydromagnetic flow through a channel", [JAP, 48(1977) 5344].
59. (with P.S. Gupta) "Heat and mass transfer on a stretching sheet with suction or blowing", [CJCE, 55(1977) 744].

60. "Hall effects on the hydromagnetic flow past an infinite porous flat plate", [JPSJ, 43(1977) 1767].
61. (with B.S. Dandpath) "Notes on the flow near a wall and dividing streamline intersection", [AIAA, 16(1978) 849].
62. (with B.S. Dandpath) "Long waves on a layer of a viscoelastic fluid flowing down an inclined plane", [RA, 17(1978) 492].
63. (with A. Chakraborty) "Hydromagnetic flow and heat transfer over a stretching sheet", [QAM, 37 April (1979) 73].
64. (with M. Das Gupta) "Convective instability of a layer of a ferromagnetic fluid rotating about a vertical axis", [IJES, 17(1979) 271].
65. (with K. Rajagopal) "Flow and stability of second-grade fluids between two parallel plates", [AM, 33(1981) 5].
66. "On a boundary layer theory for non-Newtonian fluids", [LAES, 18(1980) 875].
67. (with N. Annapurna) "Exact analysis of unsteady M.H.D. convective diffusion", [PRSL, A 367(1979) 281].
68. (with B.S. Dandpath) "Thermal instability in a porous medium with random vibrations", [AM, 43(1982) 37].
69. (with A. Chakraborty) "Nonlinear thermohaline convection in a rotating porous medium", [MRC, 8(1981) 9].
70. (with C.S. Yih) "Plane buoyant plumes", [RBCM, 111(1981) 49].
71. (with P. Muhuri)."Free convection boundary layer on a flat plate due to small fluctuations in surface temperature", [ZAMM, 59(1979) 117].
72. (with K. Rajagopal) "On a class of exact solutions to the equations of motion of a second-grade fluid", [IJES, 19(1981) 1009].
73. (with K. Rajagopal) "Flow and stability of a second-grade fluid between two parallel plates rotating about non-coincident axes", [IJES, 19(1981) 1401].
74. "Free convection effects on the flow past an accelerated vertical plate in an incompressible dissipative fluid", [RRSTMA, 24(1979) 561].
75. (with N. Annapurna) "Dispersion of matter in flow of a Bingham plastic in a tube", [CEC, 8(1981) 281].
76. (with R.N. Jana and N. Datta) "Unsteady flow in the Ekman layer of an elasto-viscous liquid", [RA, 21(1982) 733].
77. (with K. Rajagopal and B.S. Dandpath) "On nonlinear stability of flow of a conducting fluid past a porous flat plate in a transverse magnetic field", [ARMA, 83(1983) 91]
78. (with T.Y. Na and A. Nanda) "Hydromagnetic flow in a channel with volume sources or sinks of mass", [JNAM, 1(1983) 1].
79. (with K. Rajagopal) "Remarks on 'A class of exact solutions to the equations of a second-grade fluid", [LAES, 21(1983) 61].
80. (with K. Rajagopal and T.Y. Na) "A note on Falkner-Skan flows of a non-Newtonian fluid", [JNM, 18(1983) 313].
81. (with P. Muhuri) "Stochastic stability of tethered buoyant platforms", [OE, 10(1983) 471].

82. (with K. Rajagopal and T.Y. Na) "Flow of a viscoelastic fluid over a stretching sheet", [RA, 23(1984) 213].
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84. (with K. Ganguly and S.N. Bhattacharyya) "Instability of rotating flow in magnetogas-dynamics", [JMPS, 18(1984) 629].
85. "Heat transfer in a corner flow with suction", [MRC, 11 (1984) 55].
86. (with K. Rajagopal). "An exact solution for the flow of a non-Newtonian fluid past an infinite porous plate", [M, 19(1984) 158].
87. (with S.N. Bhattacharyya) "On the stability of viscous flow over a stretching sheet", [QAM, XLII (1985) 359].
88. (with S.N. Bhattacharyya) "Thermoconvective waves in a binary mixture", [PF, 28(1985) 3215].
89. (with B.K. Datta and P. Roy) "Temperature field in flow over a stretching sheet with uniform heat flux", [ICHMT, 12(1985) 89].
90. (with N. Annapurna and B.S. Dandpath) "Hydromagnetic convective diffusion between parallel plates with suction", [JAM (Trans. ASME, U.S.A.) 52(1985) 213].
91. (with G. Biswas and S.K. Som) "Instability of a moving cylindrical liquid sheet", [JFE, 107(1985) 451].
92. (with K. Ganguly) "On the hydromagnetic stability of helical flows", [JMAA, 106(1985) 26].
93. (with K. Ganguly and S.N. Bhattacharyya) "On the linear stability of hydromagnetic flow for non-axisymmetric disturbances", [JMAA, 122(1987) 408].
94. (with G. Biswas and P.K. Nag) "Heat transfer in a corner flow", [WS, 21(1987) 13].
95. (with B.K. Datta) "Cooling of a stretching sheet in a viscous flow", [IECS, 26(1987) 333].
96. (with G. Biswas) "Spreading of non-Newtonian fluid drops on a horizontal plane", [MRC, 14(1987) 361].
97. (with G. Mandal and I. Pop) "Magnetohydrodynamic flow of an incompressible viscous fluid caused by axisymmetric stretching of a plane sheet", [MG, 23(1987) 10].
98. (with K Rajagopal and T.Y. Na) "A non-similar boundary layer on a stretching sheet in a non Newtonian fluid with uniform free stream", [JMPS, 21(1987) 189].
99. "Final stage of a falling triangular plate", [W, 127(1988) 111].
100. (with P. Ray, S.K. Bayen and B.K. Datta) "Mass transfer with chemical reaction in a laminar falling film", [WS, 22(1988) 195].
101. (with S.N. Bhattacharyya) "Thermoconvective waves in a rotating fluid", [PR, 38(1988) 2440].
102. (with B.S. Dandpath) "Flow and heat transfer in a viscoelastic fluid over a stretching sheet", [IJNM, 24(1989) 215].
103. (with M.K. Laha and P.S. Gupta) "Heat transfer characteristics of the flow of an incompressible viscous fluid over a stretching sheet", [WS, 24(1989) 151].
104. "Heat transfer in a pulsatile flow of an elastico-viscous fluid in a porous plate channel", [Modelling, SC, B, AMSE Press, 31(1990) 1].

105. “Mixed convection of an incompressible viscous fluid in a porous medium past a hot vertical plate”, [IJNM, 25(1990) 723].

106. (with K. Ganguly and S.N. Bhattacharyya) “On the onset of thermal instability in fluid-filled porous spheres and spherical shells”, [SAACM, 1(3) (1991) 213].

107. (with B.S. Dandpath) “Stability of a thin layer of a second-grade fluid on a rotating disk”, [IJNM, 26(1991) 409].

108. “Hydromagnetic wave in a non-Newtonian fluid”, [MRC, 19(1 992) 237].

109. “Hydromagnetic stability of a stratified parallel flow varying in two directions”, [ASS, 198(1992) 95].

110 (with H.I. Andersson, B. Holmedal and B.S. Dandpath) “Magnetohydrodynamic melting flow from a horizontal rotating disk”, [MMMAS, 3(1993) 373].

111. (with G.C. Layek, M.K. Maity and P. Niyogi) “Unsteady convective diffusion in a rotating parallel plate channel”, [WS, 29(1994) 425].

112. (with S.N. Bhattacharyya) “Transient compressible boundary layer on a wedge impulsively set into motion”, [AAM, 66(1996) 336].

113. (with S.B. Hazra and P. Niyogi) “On the dispersion of a solute in oscillating flow through a channel”, [HMT, 31(1996) 249].

114. (with B. Pal and J.C. Misra) “Steady hydromagnetic flow in a slowly varying channel”, [PNAS, 66(A) 111 (1996) 247].

115. (with B.S. Dandpath) “Solitary waves on the surface of a layer of viscoelastic fluid running down an inclined plane”, [RA, 36(1997) 135].

116. “Propagation of NM thermoconvective waves”, [IJPAM, 28(5) (1997) 713].

117. (with S.B. Hazra and P. Niyogi) “On the dispersion of a solute in oscillating flow of a non-Newtonian fluid in a channel”, [HMT, 32(1997) 481].

118. (with J.C. Misra and B. Pal) “Hydromagnetic flow of a second-grade fluid in a channel—some applications to physiological systems”, [NMIMAS, 8(1998) 1323].

119. (with S. Bhattacharyya) “MH flow and heat transfer at a general three-dimensional stagnation point”, [IJNM, 33(1998) 125].

120. (with S. Bhattacharyya and A. Pal) “Heat transfer in the flow of a viscoelastic fluid over a stretching surface”, [HMT, 34(1998) 41].

121. (with R. Deka) “Flow past an accelerated horizontal plate in a rotating fluid”, [AM, 138(1999) 13].

122. “Soret effect on propagation of thermoconvective waves in a binary mixture”, [HMT, 35(1999) 315].

123. (with J.C. Misra, B. Paland A. Pal) “Hydromagnetic flow of a viscoelastic fluid in a parallel plate channel with stretching walls”, [IJM, 41(1999) 231],

124. “Some new similarly solutions of the unsteady Navier-Stokes equations”, [MRC, 27(2000) 485].

125. (with. J.C. Misra, B. Paland A. Pal) “Oscillatory entry flow in a plane channel with pulsating wall”, [IJM, 36(2001) 731].

126. (with T.R. Mahapatra) “Magnetohydrodynamic stagnation-point flow towards a stretching sheet”, [AM, 152(2001) 191].

127. (with T.Ray. Mahapatra) "Heat transfer in Magnetohydrodynamic stagnation-point flow towards a stretching sheet", [HMT, 38(2002) 517].
128. (with B. Pal, A. Pal and H.S. Takhar) "Hall effects on MH flow and heat transfer over a stretching surface", [IJAME, 8(2003) 219].
129. (with T. Ray Mahapatra) "Stagnation-point flow towards a stretching surface", [CJCE, 81(2003) 258].
130. (with C. Midya, G.C. Layek and T. Ray Mahapatra) "Magnetohydrodynamic viscous flow separation in channel with constrictions", [JFE, 125(2003) 952].
131. (with J.C. Misra and M. Reza) "Effects of suction or blowing on the velocity and temperature distribution in the flow past a porous flat plate of a power-law fluid", [FDR, 32(2003) 283].
132. (with J.C. Misra, M. Reza and V.M. Soundalgekar) "Flow in the Ekman layer on an oscillating porous plate", [AM, 165(2003) 1].
133. (with T. Ray Mahapatra) "Stagnation-point flow of a viscoelastic fluid towards a stretching surface", [IJNM, 39(2004) 219].
134. (with S. Bhattacharyya) "Instability due to a discontinuity in magnetic diffusivity in the presence of magnetic shear", [JFM, 509(2004) 125].
135. (with A. Chakraborti, B.K. Das and R.N. Jana) "Hydromagnetic flow past a rotating porous plate in a conducting fluid rotating about a non-coincident parallel axis", [AM, 176(2005) 107].
136. (with J.C. Misra and M. Reza) "Magnetohydrodynamic shear flow along a flat plate with uniform suction or blowing", [ZAMP, 56(2005) 1030].
137. (with S. Bhattacharyya, S. Mahapatra and D.K. Maiti) "Flow separation and heat transfer around a steep-edged surface roughness", [CFDJ, 14(2) 23 (2005) 180-190].
138. (with S.S. Chawla and P.K. Srivastava) "Spin-down of Von Karman flow", [IJNM, 41(2006) 426].
139. (with M. Reza) "Steady two-dimensional oblique stagnation-point flow towards a stretching surface", [FDR, 37(2005) 334].
140. (with R.K. Deka & S.K. Das) "Stability of viscous flow driven by an azimuthal pressure gradient between two porous concentric cylinders with radial flow and a radial temperature gradient", [AM, 189(2007) 73].
141. (with T. Ray Mahapatra and S. Dholey) "Heat transfer in oblique stagnation point flow of an incompressible viscous fluid towards a stretching surface", [HMT, 43(2007) 767].
142. (with T. Ray Mahapatra and S. Dholey) "Momentum and heat transfer in the Magneto-hydrodynamic Stagnation point flow of a viscoelastic fluid towards a stretching surface", [M, 42(2007) 263].
143. (with M. Reza) "Shear flow over a rotating porous plate subjected to suction or blowing", [PF, 19(2007) 073601].
144. (with R.K. Deka) "Stability of Taylor-Couette Magnetoconvection with radial temperature gradient and constant heat flux at the outer cylinder", [JFE, TA, 129(2007) 302].
145. (with T. Ray Mahapatra and S. Dholey) "Oblique stagnation-point flow of a viscoelastic fluid towards a stretching surface", [IJNM, 42(2007) 484].
146. (with D.K. Maiti and S. Bhattacharyya) "Stable/unstable stratification in thermosolutal convection in a square cavity", [JHT, TA, 130(2008) 12001-1].

147. (with M. Reza) "Momentum and heat transfer in the flow of a viscoelastic fluid past a porous flat plate subject to suction or blowing", [IJFTE, 1:3 (2008) 140].
148. (with C.G. Layek and C. Midya) "Influence of suction and blowing on vortex shedding behind a square cylinder in a channel", [IJNM, 43(2008) 979].
149. (with T. Ray Mahapatra and S.K. Nandy) "Magnetohydrodynamic stagnation-point flow of a power-law fluid towards a stretching surface", [IJNM, 44(2009) 123].
150. (with T. Ray Mahapatra and S.K. Nandy) "Analytical solution of magnetohydrodynamic stagnation-point flow of a power-law fluid towards a stretching surface", [AMC, 215(2009) 1696].
151. (with S.S. Chawla and P.K. Srivastava). "Rotationally symmetric flow over a rotating disk", [IJNM, doi : 10; 1016/J.ijnonlinmec2008.12.013].
152. (with T. Ray Mahapatra and S. Dholey) "Stability of hydromagnetic Dean flow between two arbitrarily spaced concentric circular cylinders in the presence of a uniform axial magnetic field", [PL, A, 373(2009) 4338].
153. (with T. Ray Mahapatra and S.K. Nandy) "Dual Solution of MDH Stagna ion-point Flow towards a Stretching Surface", [E, 2(2010) 299].
154. (with T. Ray Mahapatra and S.K. Nandy) "Magnetohydrodynamic stagnation-point flow over a shrinking sheet", [Accepted for publication in JAM, TA].
155. (with T. Ray Mahapatra and S. Dholey) "Magnetohydrodynamic laminar flow of a viscous fluid in a converging or diverging channel with suction at one wall and equal blowing at the other wall", [BGUMA, 11b. I (2010)].
156. (with M. Reza) "Some aspects of non-orthogonal stagnation-point flow towards a stretching surface", [E, 2(2010) 705].
157. Double-Diffusive convection and its Oceanographic Applications : [NSMMNP-2010, (2011), 74-84.]
158. (with A. Ganguly and M. Reza) : Thin-film flow of a power-law fluid down an inclined plane, [JFE, (2012), 134]

Abbreviations :

AAM—Archives of Applied Mechanics, Germany

AIAA—Amer. Inst. Aeronautics and Astronautics

AM—Acta Mechanica, Germany

Ar M—Archive Mechanica, Poland

AMC—Appl. Math. And Computation, U.S.A.

AMS—Arch. Mech. Stos., Poland

ARMA—Arch. Rational Mech and Analysis, U.S.A.

ASR—Appl. Sci. Res., Holland

ASS—Astroph. Space Sci., U.K.

AUBM—Analele Universitatii Bucuresti Mathematica, Roumania

BGUMA—Bull. Guwahati Univ. Math. Assoc.

BLRB—Bull. De L'Academie Royale de Belgique (classe de sciences)

BMDSM—Bull. Math De la Sci. Math, Roumanie
CEC—Chemical Engg. Communications, U.S.A.
CFDJ—Computational Fluid Dynamics Journ, Japan
CJCE—Canadian Journ. Of Chemical Engg.
UP—Canadian Journ. Phys.
E—Engineering, U.S.A.
FDR—Fluid Dynamics Res., Japan
HMT—Heat and Mass Transfer, Germany,
ICHMT—Int. Com. Heat Mass Transfer, U.S.A.
IECR—Industrial Engg. Chemical Res., U.S.A.
IJAME—Int. Journ. OfAppl. Mech. And Engg., Poland
IJES—Int. Journ. Engg. Sci, U.S.A.
IJFTE—Int. Journ. Of Fluid and Thermal Engg.
IJHMT—Int. Journ. Heat Mass Transfer, U.S.A.
IJM—Indian Journ. Math.
IJNM—Int. J. Nonlinear Math.
IJP—Indian J. Phys.
IJPAM—Indian J. Phys. And Applied Math.
JAM—Journ. Appl. Mech.
JAP—Journ. Appl. Phys., U.S.A.
JASS—Journ. Aero Space Sci., U.S.A.
JFE—Journ. Fluid Engg., U.S.A.
JFM—Journ. Fluid Mechanics, U.K.
JHT—Journ. Heat Transfer, U.S.A
JJAP—Japanese Journ. Of Applied Physics
JMAA—Journ. Of Math. Analysis andAppli., U.S.A.
JMPS—Journ. Math. Physical Sciences
JNAM—Journ. Natl Acad. Math.
XYM—Journ. Nonlinear Mech., U.S.A.
JPSJ—Journ. Phys. Soc. Japan
LAES—Letters in Appl. Engg. Sci., U.S.A.
M—Meccanica, Italy
MG—Magnitnaya Girodinamika, U.S.S.R
MA1AS—Math. Model. And Methods in Appli. Sci., Italy
MRC—Mech. Res. Commu., U.S.A.
NSMMNP—Natl. Sem. Math. Modeling of Natural Phenomena

OE—Ocean Engineering, U.K.
PCPS—Proceed. Cambridge Philosophical Soc., U.K.
PDIM—Publ. de L'Institute Mathematique (Belgrade)
PF—Physics of Fluids, U.S.A.
PL—Phys. Letters
PM—Progress of Mathematics
PNAS—Proceed. National Acad. Sci.
PR—Physical Review, U.S.A.
PRSL—Proceed. Royal Soc., London
QAM—Quarterly of Applied Math., U.S.A.
RA—Rheologica Acta
RBCM—Rev. Br. C. Mechanique, Rio di Janeiro
RRMPA—Rev. Roum. De Math. Pures et Appli
RRP—Rev. Roum. De Physique
RRSTMA—Rev. Roum. Sci. Tech. Mech. Appl.
SAACM—Stability and Appl. Annal Continuous Media, Italy.
SC—Simulation and Control
TA—Trans. ASME, U.S.A.
W—Wear, England.
WS—Warme-und-stoff., Germany
ZAMM—Zeit. Ang. Math. Mech.
ZAMP—Zeit. Ang. Math. Physics.

Jyoti Das (nee Chaudhuri)

Jyoti Das is the greatest lady mathematician not only in Bengal but perhaps in the whole of Eastern India. She is a brilliant product of the Department of Pure Mathematics, University of Calcutta. She is a great researcher, an outstanding teacher and a very sincere and careful research guide.

Jyoti Chaudhuri, as she was known, prior to her marriage, was born on August 21, 1937 in Calcutta in a middle class Bengali family. She had her education in Calcutta and she completed her B.Sc. degree standing first class first with Honours in Mathematics from the Scottish Church College, Calcutta in 1956. She topped the list of all successful candidates in B.A. and B.Sc. Examinations of the University of Calcutta that year. She was awarded the Alfred Clarke Edward Scholarship, four gold medals, three silver medals and a book prize for her superlative scholastic performance. In 1958, she repeated the performance, standing first class first in the M.Sc. Examination in Pure Mathematics and simultaneously topping the list of successful candidates at the M.A. and M.Sc. Examinations of the University of Calcutta that year. She was once again awarded four gold medals and a book prize for her exemplary academic achievements.

After a brief stint of teaching in an undergraduate college in Calcutta, she obtained the commonwealth scholarship and proceeded to the University of Oxford, U.K. to work for her Doctoral degree and in 1964, she was awarded the D.Phil degree by the University of Oxford for her original research on the "Theory of Eigenfunction Expansions".

Dr. Jyoti Das has a long and illustrious teaching experience. Right after completing her M.Sc. degree, she started teaching in Lady Brabourne College of Calcutta. After returning from Oxford University, in 1964, she took up a faculty position in the Jadavpur University of Calcutta in 1965. After a brief stint there in 1966, she again left for the University of Dundee in Scotland and taught and continued her research work there. In 1968, she finally came back to India and served the Indian Institute of Technologies in Madras and Kharagpur for nearly seven years. In 1975, she ultimately came back to Calcutta and joined her alma mater, the Department of Pure Mathematics of the Calcutta University as a Reader. In 1979, she became the Sir Asutosh Birth Centenary Professor of Higher Mathematics (previously known as Hardinge Professor) and became the first lady mathematician in India to hold a Chair Professorship in Mathematics. She worked in that capacity till the age of 65 and finally retired from the University of Calcutta in 2002.

Now we shall briefly discuss her research activities. The research activities of Professor Jyoti Das in the area of Mathematics can be divided into the following four branches :

1. Special Functions
2. Eigenfunction Expansions,
3. Basics of Ordinary Differential Equations
4. Some Elementary Mathematics.

I. Jyoti Das started her research career, by working on special

Functions under the guidance of Sri Bhola Nath Mukherjee, widely known as the co-author of many text books on undergraduate mathematics. In this area, she published six papers between 1962 and 1967. [1962(3), 1966, 1967(2)] For forty years after that she concentrated on other areas mentioned above, but after that from 2007 onwards she has again taken up research on special functions and has published related research papers in 2007, 2008, 2011, 2012 and 2013. During this later phase of research Dr. Das has answered two pertinent questions related to special functions. They may be framed as follows :

i Why are these functions named special functions ?

ii. How to get hold of the generating function of a given sequence of special functions, instead of simply verifying the result, the corresponding generating function being supplied, which has been the usual practice so far.

Further in 2013 (4), Professor Das has proposed a generalization of the well-known Hermite polynomials. The study of these generalized polynomials is still awaited.

II. In the interim period, 1962, Jyoti Das started her research work

for the degree of Ph.D. at the University of Oxford, in the theory of Eigenfunction Expansions, under the guidance of the world-famous mathematician Professor E.C.Titchmarsh. It might be noted here that the starting of research career of Jyoti Das was not at all smooth. Towards the end of 1959, she enrolled herself as a research scholar in the Department of Pure Mathematics, Calcutta University, under the pupervision of Dr. H.M. Sengupta, being supported by a University Scholarship. Unfortunately, the scenario changed abruptly with the sudden demise of Dr. Sengupta, which forced her to give up the scholarship. In January, 1961, she was appointed by the P.S.C., West Bengal, as a Lecturer in Mathematics, in Lady Brabourne College in Calcutta.

In October, 1962, Jyoti Das joined the University of Oxford, as a commonwealth scholar, to carry on research work under the guidance of the Savalian Professor of Mathematics, the renowned analyst, Professor E. C. Titchmarsh. But ill-fate did not leave Jyoti Das. Professor Titchmarsh expired in January, 1963. She was then left with three options : (i) to go back to India failing to carry on research under such an illustrious person like Professor Titchmarsh; (ii) to enroll herself in some other university of U.K.; (III) to continue her research work in Oxford under the guidance of Dr. J.B. Mcleod, a student of Professor Titchmarsh. Jyoti Das chose the third option, as she was not willing to return to India without a Doctoral degree, though she was very much concerned about her past records of losing her supervisors.

Failing to crack the problem suggested by Dr. Mcleod, Jyoti Das turned her attention to a problem on fourth-order ordinary differential equation and successfully completed it. As the corresponding problem on second-order ordinary differential equation is not solvable, neither Dr. Mcleod nor Dr. Everitt was willing to accept Jyoti Das's solution for the fourth order ordinary differential equation, until she pointed out the advantage of the fourth-order problem over the second-order problem. Immediately the paper was sent to the Quarterly Journal of Mathematics, and it was published in 1964. Jyoti Das reported the same problem in the British Mathematical

Colloquium, 1963. Starting with the above-mentioned problem, Jyoti Das completed her research works for the Doctoral degree in a little more than a year and received D.Phil degree from the University of Oxford in May, 1964. She continued her research work in this field till 2004. During this period, she published thirty-two research papers in the area of Eigenfunction Expansions and related topics. Some of these papers were written jointly with Professor W.N.Everitt, a renowned mathematician in this field. Special mention must be made of the paper entitled "On the square of a formally self-adjoint differential expression" [J. London Math. Soc.(2), 1, PP. 661-673] (with W.N. Everitt), published in 1969, as it opened up a new line of thought in the field. The paper determined the crucial clue necessary for the study of iterated second-order linear differential operators. Hundreds of papers have been written till date on this topic initiated by Professor Das and W.N. Everitt. A little history is associated with this problem. J. Das (nee Chaudhuri) after coming back from Oxford in 1964, started working on the problem of the square of a formally self-adjoint second-order differential expression and communicated on the problem with Dr. W. N. Everitt, which continued for more than a year. Failing to arrive at a proper solution of the problem, Dr. Everitt decided to sit together so as to resolve the problem. For this he arranged for Jyoti Chaudhuri a lecturership of Queen's College, Dundee, where he was working. It was definitely an unprecedented move. J. Chaudhuri was also so keen on solving the problem that she did not hesitate to resign from the post of a Reader in mathematics, Jadavpur University, as she was not granted the required leave of absence without giving a bond for serving the University for three years after coming back. The story does not end here. Dr. J. Chaudhuri joined Queen's College, Dundee, in October, 1966, but the problem could not be solved till September, 1967. By then, the Queen's College, Dundee was upgraded to the status of the University of Dundee and Jyoti Chaudhuri was offered permanent membership of the Faculty of the University. She refused the offer as she had the intention of serving her motherland.

In 1989, Professor Jyoti Das employed co-ordinate geometry to establish Weyl's limit classification of second-order ordinary differential equations. Normally, to analyze a nonlinear equation one considers a linear approximation of the given nonlinear equation and employs linear analysis to it to arrive at some result. The reverse process has never been encountered. In 1996 (3) Professor J. Das showed that sometimes nonlinear analysis comes handy in obtaining information about linear equation.

III. Lately, Professor Das has turned her attention to the basic theory of ordinary differential equations.

In 1998(3) , Professor Jyoti Das developed a new method of solving linear differential equations using functional analysis, which was a remarkable interdisciplinary work.

In 2002 (2), she solved an apparently complicated ordinary differential equation by a strikingly simple method.

In 2004 (1). She introduced the notion of "Natural Boundary conditions of second-order linear ordinary differential equations", which indicated the necessity of revisiting the well-known Strum-Liouville Problems.

In 2010, she produced an algorithm for solving systems of linear first-order ordinary differential equations with constant coefficients. In 2013 (1), she extended the method to systems of linear first-order ordinary differential equations with variable coefficients. Also she exhibited the use of nonlinear ordinary differential equations for some systems of ordinary first order differential equations for which the above mentioned method is not applicable.

Professor Das has also associated the geometrical characteristics of a family of curves with the corresponding differential equations : [2010 (1)].

IV. In two of her publications [2002, 2004], Professor Das has pointed out there is much scope of doing research at the elementary level of mathematics, like generalizations of Leibnitz's rule, Rolle's Theorem etc. She also generalized Brahmagupta's triangle as a tribute to him on his 1500th Birth Anniversary.

Many students have done their Ph.D.'s under the guidance of Professor J. Das. Six students have already obtained their degrees, two others are still working under her. V. Krishna Kumar and Jayasri Sett are two of her well-known students. While the first six of her Ph.D. students worked on the theory of eigenfunction expansions, the seventh student worked on a fundamental question of special functions. The topic of the dissertation of her present Ph.D. student is remarkably on an innovative idea of associating geometrical interpretations with subsets of the solution set of given first order partial differential equations.

Professor Jyoti Das, apart from her mathematical commitments, has served in many important National and State academic committees. She has received recognition from many learned bodies.

Apart from doing serious research in Mathematics, Professor Das has also devoted her time in popularising mathematics, by writing several articles and rhymes in Bengali on mathematics that is in the curriculum of the school and undergraduate levels.

A simple and humane person, a brilliant teacher, who was awarded the "outstanding faculty" award by the University of Calcutta is one of the last legendary mathematicians to adorn the University as a superlative researcher who did path-breaking research in her own field. We give here a complete list of her research publications.

List of Publications by Dr. (Mrs.) Jyoti Das [nee Chaudhuri]

1. "On Bateman-integral functions", [MZ, 78, (1962), 25-32]
2. "On a relation connecting the second solution of Tchebycheff's equations of the second and Bessel functions", [ADF, X, (1962), 123-129]
3. "A note on definite integrals involving the derivatives of hypergeometric polynomials", [RSMUP, XXXII, (1962), 214-220]
4. "On the convergence of the eigenfunction expansion associated with a fourth-order differential equation, [QJM, 15, (1964), 258-274]
5. "On the generalization of a formula of Rainville", [PAMS, 17, (1966), 552-556]
6. "On the operational representation of some hypergeometric polynomials", [RSMUP, XXXVIII, (1967), 27-32]

7. “Some special integrals”, [AMM, 74, (1967), 545-548]
8. (With W.N. Everitt) “On the spectrum of ordinary second-order differential operators”, [PRSE, LXVIII, (1968), 95-1191
9. (With W.N. Everitt) “On an eigenfunction expansion for a fourth-order singular differential equation”, [QJM, 20, (1968), 195-213]
10. (With W.N. Everitt) “On the square of a formally self-adjoint differential expression”. [JLMS, (2), 1, (1968), 661-673]
11. (With W.N. Everitt) “The spectrum of a fourth-order differential operator”, [PRSE, LXVIII, (1968), 185-210]
12. (With W.N. Everitt) “On the distribution of the eigenvalues and the order of the eigenfunctions of a fourth-order singular boundary value problem”, [PRSE, (A) 71, (1971/72), 61-75]
13. (With V. Krishna Kumar) “On the eigenfunction expansion associated with a singular complex valued fourth-order differential equation”, [PRSE, 75A, (1975-76), 325-332]
14. (With J. Dey) “On the separation property of symmetric ordinary second-order differential expressions”, [QM, 1, (1976), 145-154]
15. (With J. Sett) “On the separation property of symmetric ordinary fourth-order differential expressions, [PRSE, 86A, (1980), 255-259]
16. (With M. Majumdar) “On the invariance of the nature of singularities of the m-coefficients associated with an ordinary linear fourth-order differential equation”, [JPM, 3, (1983), 25-30]
17. (With G. Laha) “A Hilbert space associated with a singular second-order boundary value problem”, [JPM, 3, (1983), 31-36]
18. (With J. Sett) “A note on the separation property of symmetric fourth-order differential expressions”, [JIIS, 65(B), (1983),173-177]
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Abbreviations :

AA—Applicable Analysis

ADUF—Annali dell' Universita di Ferrara

AM—Archivum Mathematicum

AMM—American Mathematical Monthly

BCMS—Bull. Cal. Math. Soc.

BPAM—Bull. Pure and Appl. Maths.

FEJMS—Far East Journ. Math. Sciences

IEEMS—Int. Electronics Engg. Math. Soc.

IJM—Indian Journ. of Maths.

IJMEST—Int. Journ. Math. Edu. Sci. Techno.

IJPAM—Indian J. of Pure and Appl. Maths.

JA—Journ. Analysis
JAuMS—Journ. Australian Math. Soc.
JIIS—Journ. Indian Institute of Science
JLMS—Journ. London Math. Soc.
JMAA—Journ. Math. Anal. & Applications
JOMS—Journ. Orissa Math. Soc.
JPM—Journ. Pure Math.
JTS—Journ Tensor Soc.
MZ—Math. Zeitschr.
PAMS—Proc. Amer. Math. Soc.
PRSE—Proc. Royal Soc. Edinburgh
QJM—Quart. Journ. Math.
QM—Questiones Mathematica
R—Resonance
RSMUP—Rendiconti del Seminario Mathematica della Universita di Padova
TMS—The Math. Student